IEEE WCCI 2014

Final Program and Book of Abstracts

2014 IEEE World Congress on Computational Intelligence

July 6 – 11, 2014, Beijing, China

Welcome Message from General Chairs

It is our great honor to welcome you to the 2014 IEEE World Congress on Computational Intelligence (IEEE WCCI 2014), held in Beijing, China, during July 6 – 11, 2014. IEEE WCCI 2014 hosted three conferences: The 2014 International Joint Conference on Neural Networks (IJCNN 2014), the 2014 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE 2014), and the 2014 IEEE Congress on Evolutionary Computation (IEEE CEC 2014). All of them are the flagship conferences of the corresponding fields. Beijing, as the capital of the People's Republic of China, is the nation's political, economic, and cultural center as well as China's most important center for international trade and communications. All participants of IEEE WCCI 2014 expected a technically rewarding experience as well as memorable experiences in this great city!

IEEE WCCI 2014, as a sequel of IEEE WCCI 1994 (Orlando, Florida, USA), IEEE WCCI 1998 (Anchorage, Alaska, USA), IEEE WCCI 2002 (Honolulu, Hawaii, USA), IEEE WCCI 2006 (Vancouver, BC, Canada), IEEE WCCI 2008 (Hong Kong, China), IEEE WCCI 2010 (Barcelona, Spain), and IEEE WCCI 2012 (Brisbane, Australia), engaged in cross-fertilization among the three big areas, i.e., neural networks, fuzzy systems, and evolutionary computation, and provided a stimulating forum for scientists, engineers, educators, and students from all over the world to discuss and present their research findings on computational intelligence. It received 2381 submissions from more than 50 countries and regions. Based on rigorous reviews, 1427 papers were selected for publication in the proceedings. The papers collected in the proceedings cover a broad spectrum of the fields of computational intelligence. In addition to the contributed papers, several distinguished scholars (Xin Yao, Jose Principe, Jerry Mendel, Yann LeCun, George Burgin, Zongben Xu, Kazuo Tanaka, Kalyan Deb, Don Wunsch, Fei-Yue Wang, Ken Stanley, Tianyou Chai, Janusz Kacprzyk, Jason Lohn, Karlheinz Meier, Huaguang Zhang and Edward Tsang) were invited to give plenary and invited lectures, providing us with recent hot research topics, latest developments and novel applications.

IEEE WCCI 2014 was sponsored by the IEEE Computational Intelligence Society, the Chinese Academy of Sciences, the National Natural Science Foundation of China, Intel, and The State Key Laboratory of Management and Control for Complex Systems, and joint sponsored by the International Neural Network Society, the Evolutionary Programming Society, and the Institution of Engineering and Technology. We wish to express our appreciation and gratitude to all individuals who have contributed to IEEE WCCI 2014 in a variety of ways. Special thanks are extended to our colleagues for their thorough review of all the submissions, which is vital to the success of this congress, and also to the members of the organizing committee and our volunteer students who have dedicated their time and efforts in planning, promoting, organizing and helping the congress. Our special thanks go to distinguished plenary and invited lecturers, as well as all the authors for contributing their latest research work to the congress, and to all the participants in making IEEE WCCI 2014 a memorable event. We are very grateful to the Chinese Academy of Sciences, the National Natural Science Foundation of China, and Intel for their financial support. Enjoy the congress!

Derong Liu
IEEE WCCI 2014
General Chair

Jennie Si
IEEE WCCI 2014
General Co-Chair

Welcome Message from Program Chairs

We are proud that the annual International Joint Conference on Neural Networks (IJCNN) – the flagship conference of the IEEE Computational Intelligence Society and the International Neural Network Society, the annual IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) – the foremost conference in the field of fuzzy systems, and the annual IEEE Congress on Evolutionary Computation (IEEE CEC) – the leading event in the field of evolutionary computation, join again in Asia. Following the IEEE World Congress on Computational Intelligence (WCCI) event series we are very pleased to have the 2014 edition in Beijing, China on July 6 – 11, 2014. China is a vast country characterized by a boosting economy, and unique natural and cultural treasures. Moreover, Beijing is an exciting location which has intrigued travelers for centuries as it does nowadays as you will experience yourself by exploring Beijing's ancient past and enjoying its exciting modernity. We take this unique opportunity and offer a very warm welcome to all congress attendees!

IEEE WCCI 2014 attracted a large number of high quality submissions (2381) from all over the planet: 959 submissions for IJCNN, 553 submissions for FUZZ-IEEE, and 869 for IEEE CEC. Papers cover a huge spectrum of research topics in computational intelligence, spanning from the fields of neural networks and machine learning to fuzzy systems and evolutionary computation. Based on the very hard work of the corresponding International Program Committee members and reviewers (thanks to you all for the huge work done!), 1427 papers were accepted and included in the congress proceedings. More in detail, IJCNN 2014 hosts 619 papers, FUZZ-IEEE 2014 hosts 371 and IEEE CEC 2014 accepted 437 papers. The acceptance rate of IEEE WCCI 2014 hence is 59.9%.

The program booklet provides materials to guide the congress attendees in this unique scientific experience. Here, you will find the location of the session rooms, maps of the congress venue, the Beijing International Convention Center as well as the day-by-day program and abstracts of the plenary and invited lectures..

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Welcome to Beijing, *Nihao*!

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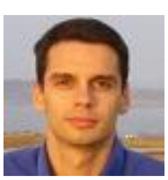

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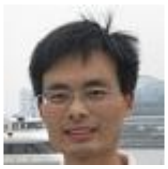

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Xin Yao, University of Birmingham, United Kingdom
Haluk Yapicioglu, Anadolu University, Turkey
Keiichiro Yasuda, Tokyo Metropolitan University, Japan
Zhengmao Ye, Southern University, USA
Gary Yen, Oklahoma State University, USA
Peng-yeng Yin, National Chi Nan University, Taiwan
Chao Yu, Peking University, China

Jian Qiao Yu, The University of Hong Kong, Hong Kong
Yang Yu, Nanjing University, China
Kevin Kam Fung Yuen, Xi'an Jiaotong-Liverpool University, China
Daniela Zaharie, West University of Timisoara, Romania
Saul Zapotecas-Martinez, CINVESTAV-IPN, Mexico
Christine Zarges, University of Birmingham, United Kingdom
Baihai Zhang, Beijing Institute of Technology, China
Jie Zhang, Newcastle University, United Kingdom
Junqi Zhang, Tongji University, China
Li Zhang, Soochow University, China
Lifeng Zhang, Renmin University of China, China
Qieshi Zhang, Shaanxi Normal University, China
Qingfu Zhang, University of Essex, United Kingdom
Yi Zhang, Sichuan University, China
Yongpeng Zhang, Prairie View A-M University, USA
Shaoqiu Zheng, uni, China
Jiarui Zhou, Zhejiang University, China
Jiarui Zhou, Shenzhen University, China
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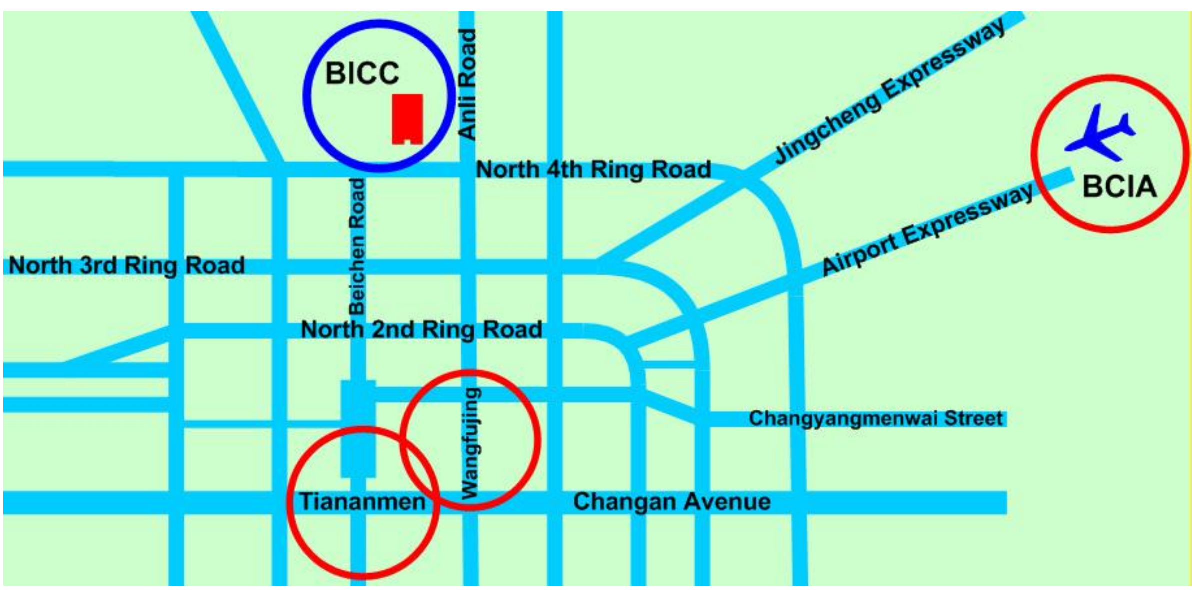
- Institution of Engineering and Technology

Congress Venue

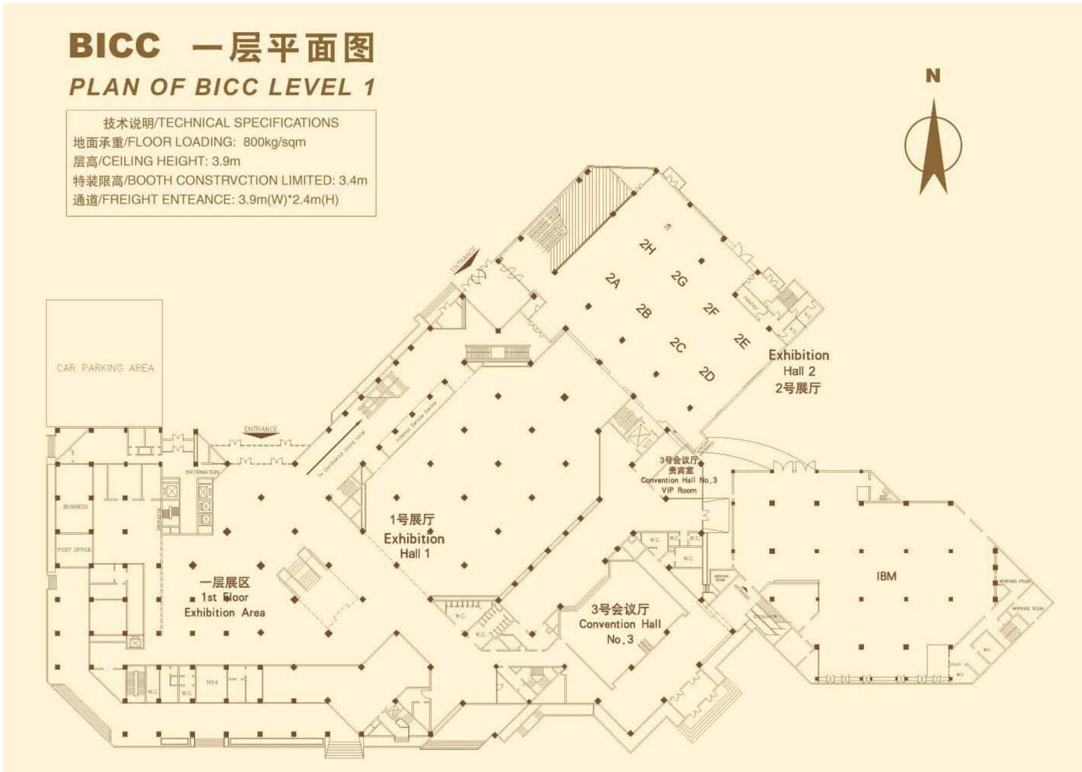
IEEE WCCI 2014 will be held at the Beijing International Convention Center (BICC), which is on the North 4th Ring Road of Beijing and along the capital axis line. It is right across the street from the center of 2008 Beijing Olympic Games – Beijing National Stadium, known as the "Bird's Nest", and the Aquatic Center, known as the "Water Cube".

The BICC is 20 kilometers from the Beijing Capital International Airport (BCIA) and 9 kilometers from the city center.

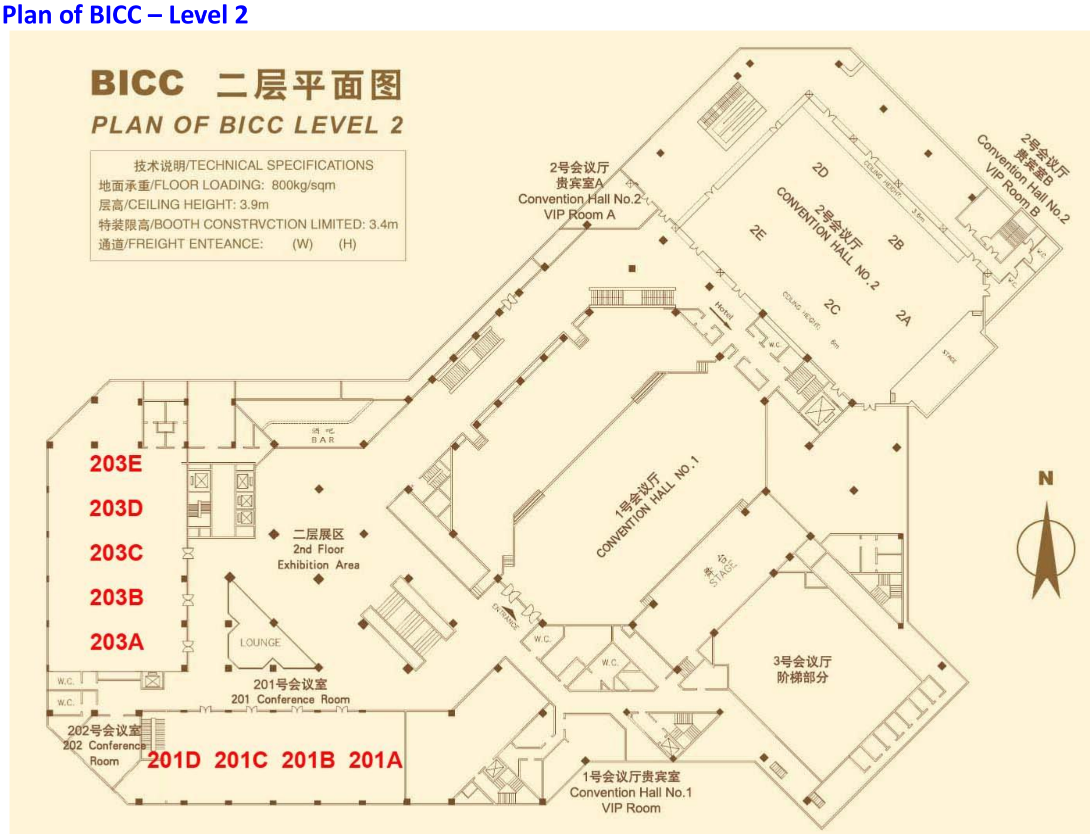


The BICC has a total of 60,000 square meters and has over 40 conference rooms. It has an Exhibition Hall of 5,000 square meters and 20,000 square meters of office space. It is the ideal place for holding big conferences like IEEE WCCI. The floor plans of BICC (Level 1, Level 2, and Level 3) are shown as follows.

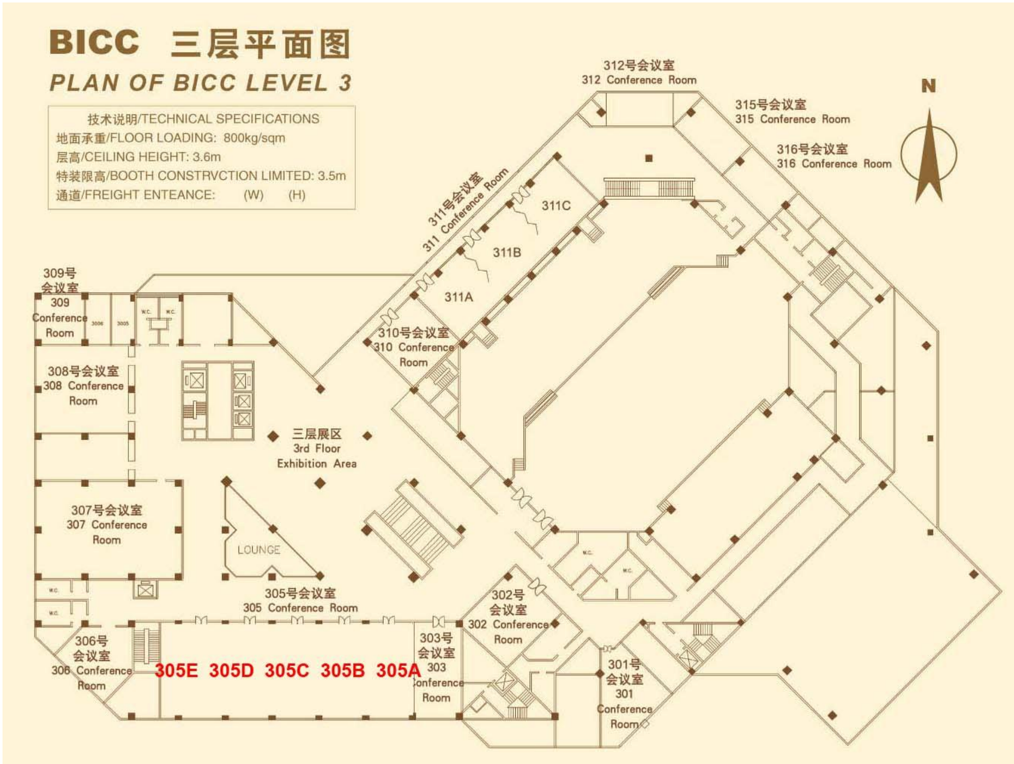
Plan of BICC – Level 1



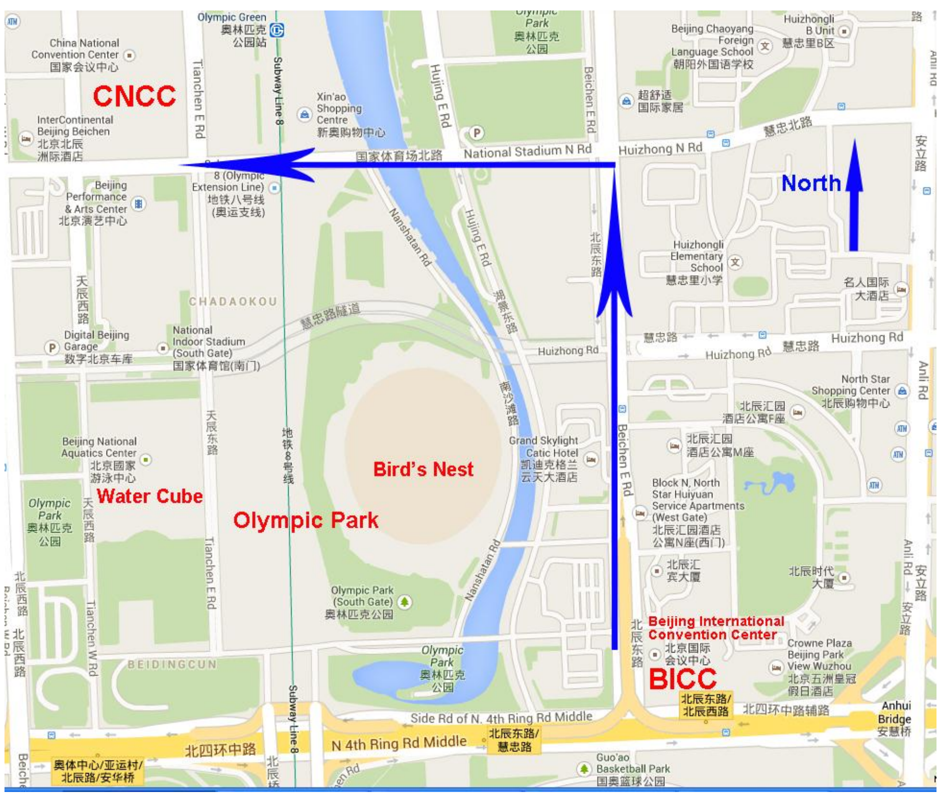
Plan of BICC – Level 2



Plan of BICC – Level 3



The banquet and award ceremony of IEEE WCCI 2014 will be held at China National Convention Center (CNCC), located at No. 7 Tianchen East Road. The route from BICC to CNCC is indicated in the following map.



The North Star Continental Grand Hotel, which is a four star hotel, is directly connected to BICC and is designated as the congress hotel.

Hotel address:

- Beijing North Star Continental Grand Hotel
- 8 Beichen East Road, Chaoyang District
- Beijing 100101, China
- Phone: +86 10 84985588

To its east side, the Continental Grand Hotel is directly connected to a five star hotel (North Star Crown Plaza Wu Zhou Hotel) which has 500 rooms. Nearby, within five minute walking distance, there are several three star hotels including North Star Yayuncun Hotel, North Star HuiYuan Service Apartment, National Jade Hotel, and few others with more than 800 rooms total.

A map showing all these different hotels is shown below.

亚运村平面位置示意图
Plan Of YaYunCun

General Information

Registration Information

The IEEE WCCI 2014 registration desk will be located at the 3rd floor lobby of the Intelligence Building, Institute of Automation, Chinese Academy of Sciences (CASIA), on July 6, 2014. It will be open during the following hours:

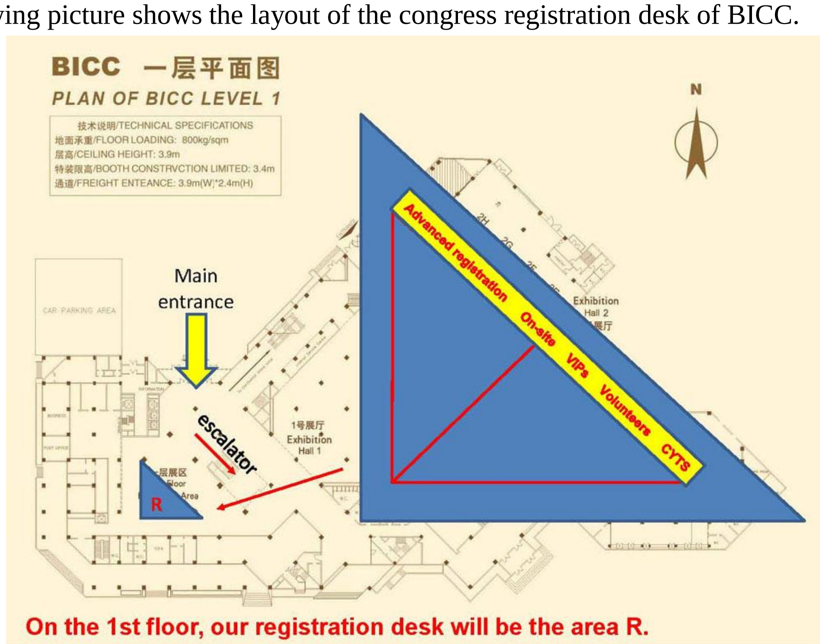
- July 6, 2014 (Sunday) 08:00 – 11:30

The address of CASIA is: No. 95, Zhongguancun East Road, Haidian District, Beijing. Some shuttle buses will be arranged for the convenience of the transportation between the conference hotel and CASIA on July 6, 2014.

After that, the IEEE WCCI 2014 registration desk will be moved to Beijing International Convention Center (BICC). The registration desk in BICC will be open during the following hours:

- July 6, 2014 (Sunday) 14:00 – 20:00
- July 7, 2014 (Monday) 08:00 – 17:00
- July 8, 2014 (Tuesday) 08:00 – 17:00
- July 9, 2014 (Wednesday) 08:00 – 17:00
- July 10, 2014 (Thursday) 08:00 – 17:00
- July 11, 2014 (Friday) 08:00 – 14:00

The following picture shows the layout of the congress registration desk of BICC.



Full registration fee includes admission to all sessions (plenary sessions and technical sessions), coffee breaks, lunches, one ticket for the opening reception and one ticket for the banquet, as well as one copy of the program book and one copy of the CD-ROM proceedings.

Student registration fee includes admission to all sessions (plenary sessions and technical sessions), coffee breaks, lunches, one ticket for the opening reception, as well as one copy of the program book and one copy of the CD-ROM proceedings.

Each extra copy of CD-ROM proceedings will be $55. Each extra banquet ticket costs $100.

Guidelines for Oral Presentation

Every oral presenter will have 15 minutes for oral presentation, plus 4 minutes for questions and 1 minute for setting up the presentation. Please strictly observe this time limit in order to facilitate people moving between sessions.

The session room will provide an overhead projector and a screen for authors to use. However, authors must bring their own laptop or to borrow one from another author presenting in the same session.

Presenters should arrive at their session a few minutes before the session starts and check that their slides work satisfactorily with the audiovisual system in the room. If not, they should let the session chair and the staff know immediately.

Guidelines for Poster Presentation

Poster session will be running in parallel with oral sessions. Poster presenters should set up their posters on time according to the conference program. We will provide adhesive tapes for holding the posters. Each poster session will last 2.5 hours, starting at the coffee break. Poster presenters are kindly required to remove their posters, once the session is over.

A poster-board will be available for each poster presenter. Each poster-board is 1m wide ×2.4m tall (3.2ft ×7.8ft). The suggested maximum size of a poster is 1m ×1.5m (3.2ft ×4.9ft). Each poster-board will have a paper number indicating the assigned poster paper. Please check this info before placing your poster, to avoid any possible overlaps with another poster presenter.

Important: A poster template is available now for each conference, i.e., IJCNN, FUZZ-IEEE and CEC. Each template is characterized by a reference color for the conference: blue for IJCNN, green for FUZZ-IEEE and orange for CEC. Please download and use the appropriate poster template. The size of the poster template is 0.84 m × 1.18 m (2.7 ft × 3.8 ft). Please use the official poster template, downloaded from http://www.ieee-wcci2014.org/presenters.htm

Each template is composed of two pages. The first page is the void template to be completed, while the second one is a sample poster that can be a useful reference.

Currency Information

Renminbi (RMB) is the only currency used in China. RMB is also called Chinese Yuan (CNY). The unit of Renminbi is Yuan and with smaller denominations called Jiao and Fen. The conversion among the three is: 1 Yuan = 10 Jiao = 100 Fen. Paper notes are issued in denominations of 1, 5, 10, 20, 50 and 100 Yuans; 1 and 5 Jiaos; and 1 and 5 Fens. Coins are issued in denominations of 1 Yuan; 1 and 5 Jiaos; and 1 and 5 Fens.

Money exchanges by cash or traveler’s cheques can be made at the branches of Bank of China, hotels and tourist stores. Please remember to keep the receipt to exchange back to foreign currency when leaving China.

Credit Cards

Visa, MasterCard and American Express are most commonly used in China. Cards can be used in most middle to top-range hotels and department stores.

Transportation

Beijing has subways, taxis, buses for public transportation. Subway is convenient for most of the time. The Beijing subway map is shown here. The nearest station to the BICC is the Olympic Green Station on subway line 8.

Some useful information between BICC and other main locations of Beijing is listed as follows, which reveals the convenience of transportation around BICC and in Beijing.

- **BCIA to BICC**
    - Subway – $2.5 / 70min
    - Taxi – $12 / 30min
    - Airport Shuttle – $2.2 / 40min
- **BICC to Forbidden City**
    - Subway – $0.3 / 30min
    - Taxi – $6 / 20min
- **BICC to Summer Palace**
    - Subway – $0.3 / 30min
    - Taxi – $6 / 20min
- **BICC to Tiananmen Square**
    - Subway – $0.3 / 30min
    - Taxi – $6 / 20min
- **BICC to Temple of Heaven**
    - Subway – $0.3 / 35min
    - Taxi – $7 / 25min

Time

GMT + 8 hours (the whole China is set to Beijing time).

Electricity

Electricity is 220 Volts, 50 AC; plugs can be three-pronged flat pins, two flat pins or two narrow round pins.

History of IEEE WCCI

2014 IEEE World Congress on Computational Intelligence
July 6 – 11, 2014
Beijing, China

2012 IEEE World Congress on Computational Intelligence
June 10 – 15, 2012
Brisbane, Australia

2010 IEEE World Congress on Computational Intelligence
July 18 – 23, 2010
Barcelona, Spain

2008 IEEE World Congress on Computational Intelligence
July 1 – 6, 2008
Hong Kong, China

2006 IEEE World Congress on Computational Intelligence
July 16 – 21, 2006
Vancouver, BC, Canada

2002 IEEE World Congress on Computational Intelligence
May 12 – 17, 2002
Honolulu, Hawaii, USA

1998 IEEE World Congress on Computational Intelligence
May 4 – 9, 1998
Anchorage, Alaska, USA

1994 IEEE World Congress on Computational Intelligence
June 26 – July 2, 1994
Orlando, Florida, USA

Plenary Lectures

Some Recent Work in Computational Intelligence for Software Engineering

Xin Yao

University of Birmingham, http://www.cs.bham.ac.uk/~xin

Abstract – Computational intelligence has been used in software engineering for a long time. There has been a recent surge in interest in this area, especially in search-based software engineering. This talk touches upon some of the recent examples in the broader field of computational intelligence in software engineering. It is highlighted that software engineering could benefit from advanced computational intelligence techniques in tackling hard problems, e.g., software module clustering, software reliability maximisation, software project scheduling, software effort estimation, software defect prediction, etc. It is also argued that new research challenges posed by software engineering could stimulate further development of new theories and algorithms in computational intelligence. Such theoretical research could shed some light on important research issues and provide guidance in future work. For example, theoretical analysis of computational time complexity of search algorithms can inform us about the limitation of search-based software engineering. The research in online learning algorithms can help us develop novel approaches to software effort estimation when historical data within a company are sparse. The primary aim of this talk is not to provide a comprehensive review of computational intelligence for software engineering, but to illustrate the opportunities for further research and development in this area through selected examples.

Biography – Xin Yao is a Chair (Professor) of Computer Science at the University of Birmingham, UK, since the April Fool's day in 1999. His major research interests include evolutionary computation, ensemble learning and their applications. His work won the 2001 IEEE Donald G. Fink Prize Paper Award, 2010 IEEE Transactions on Evolutionary Computation Outstanding Paper Award, 2010 BT Gordon Radley Award for Best Author of Innovation (Finalist), 2011 IEEE Transactions on Neural Networks Outstanding Paper Award, and many other best paper awards. He received the prestigious Royal Society Wolfson Research Merit Award in 2012 and the IEEE CIS Evolutionary Computation Pioneer Award in 2013. In recent years, he has engaged in the research of computational intelligence for software engineering, published papers in IEEE Transactions in Software Engineering (TSE), ACM Transactions on Software Engineering and Methodology (TOSEM), International Conference on Software Engineering (ICSE), etc.

Toward Cognitive Integration of Prosthetic Devices

Jose C. Principe
University of Florida, principe@cnel.ufl.edu

Abstract – Technology has impacted human life in many different ways, but has followed a predictable evolutionary path characterized by the creation of artificial systems that have either been controlled explicitly by human limbs or have been made autonomous. The latest push has been characterized by the overwhelming use of digital computers and artificial intelligence/ signal and pattern recognition algorithms. The research trend has progressively shifted towards autonomous platforms and has shown that this path, albeit full of exciting advances, is more difficult than originally thought. Machines are still today perceived as external and independent of our own bodies. The objective of this talk is to revisit the human-machine interface paradigm to provide broadband control of external machines directly through brain processes and capitalize both on the merits of biological information processing/intelligence and on man-made external devices that will enhance the reaction time, force, scale, physical locality, sensing of biological sensors and actuators.

We are at the brink of a revolutionary technology stage, where machines may be "cognitively integrated" in the human experience, manipulated and controlled through direct brain processes in virtually the same way as we see, walk or grab an external object. But unlike the current generation of brain machine interfaces, this is done through a dialogue that requires the transfer of goals between the machine and the user. The vision is a new kind of implanted prosthetics that senses intentional brain processes (e.g. moving an arm) and translates the spatio-temporal neural signals into models that control external devices. Through the perception-action-reward cycle the brain is made aware of the machine existence and actions, which will provide the basis to be considered a body extension. Several key technological and scientific developments will be discussed to implement this vision.

Biography – Jose C. Principe (M'83-SM'90-F'00) is a Distinguished Professor of Electrical and Computer Engineering and Biomedical Engineering at the University of Florida where he teaches advanced signal processing, machine learning and artificial neural networks (ANNs) modeling. He is BellSouth Professor and the Founder and Director of the University of Florida Computational NeuroEngineering Laboratory (CNEL) www.cnel.ufl.edu . His primary area of interest is processing of time varying signals with adaptive neural models. The CNEL Lab is studying signal and pattern recognition principles based on information theoretic criteria (entropy and mutual information) and applying these advanced algorithms to Brain Machine Interfaces (both motor as well as somatosensory feedback).

Dr. Principe is an IEEE, ABME, AIBME Fellow. He is the Past-Editor in Chief of the IEEE Transactions on Biomedical Engineering, past Chair of the Technical Committee on Neural Networks of the IEEE Signal Processing Society, and Past-President of the International Neural Network Society. He received the IEEE EMBS Career Award, and the IEEE Neural Network Pioneer Award. He has Honorary Doctor Degrees from the U. of Reggio Calabria Italy, S. Luis Maranhao Brazil and Aalto U. in Finland. Currently he is the Editor in Chief of the IEEE Reviews in Biomedical Engineering. Dr. Principe has more than 600 publications. He directed 79 Ph.D. dissertations and 65 Master theses. He wrote four books: an interactive electronic book entitled "Neural and Adaptive Systems: Fundamentals through Simulation" (Wiley),"Brain Machine Interface Engineering", "Kernel Adaptive Filtering" (Wiley), and "Information Theoretic Learning" (Springer).

Type-2 Fuzzy Sets and Systems: Some Questions and Answers

Jerry M. Mendel
University of Southern California, mendel@sipi.usc.edu

Abstract – There are now thousands of articles that have been written about type-2 fuzzy sets and systems. Why did such fuzzy sets come into being? Are they meant to replace type-1 fuzzy sets? How more complicated are they than type-1 fuzzy sets? So many questions!

For someone who is new to a type-2 fuzzy set, as is true for the majority of attendees at WCCI-2014, you may find its literature confounding because there are more ways to represent a type-2 fuzzy set than there are for a type-1 fuzzy set. This is due to the three-dimensional nature of the membership function of a type-2 fuzzy set as opposed to the two-dimensional nature of a type-1 fuzzy set. Having more representations to learn about may pose a barrier for newbies. My goal in the rest of this talk is to break down this barrier.

Although I could have chosen to talk about many aspects of type-2 fuzzy sets and systems including their applications (there already are two special issues of the Computational Intelligence Magazine that do this very well), I have chosen for the rest of my talk to focus on answering three barrier-busting questions:

1. What are the different ways to mathematically represent a T2 FS?
2. Why are different representations needed?
3. Which ones are useful for design?

I emphasize design because, being an engineer, I want to be able to use a type-2 fuzzy set to do something better than if I had not used it.

Biography – Jerry M. Mendel received the Ph.D. degree in electrical engineering from the Polytechnic Institute of Brooklyn, Brooklyn, NY. Currently he is Professor of Electrical Engineering and Systems Architecting Engineering at the University of Southern California in Los Angeles, where he has been since 1974. He has published over 550 technical papers and is author and/or editor of ten books, including Uncertain Rule-based Fuzzy Logic Systems: Introduction and New Directions (Prentice-Hall, 2001), Perceptual Computing: Aiding People in Making Subjective Judgments (Wiley & IEEE Press, 2010), and Advances in Type-2 Fuzzy Sets and Systems (Springer 2013). His present research interests include: type-2 fuzzy logic systems and their applications to a wide range of problems, including smart oil field technology, computing with words, and fuzzy set qualitative comparative analysis. He is a Life Fellow of the IEEE, a Distinguished Member of the IEEE Control Systems Society, and a Fellow of the International Fuzzy Systems Association. He was President of the IEEE Control Systems Society in 1986. He was a member of the Administrative Committee of the IEEE Computational Intelligence Society for nine years, and was Chairman of its Fuzzy Systems Technical Committee and the Computing With Words Task Force of that TC. Among his awards are the 1983 Best Transactions Paper Award of the IEEE Geoscience and Remote Sensing Society, the 1992 Signal Processing Society Paper Award, the 2002 and 2014 Transactions on Fuzzy Systems Outstanding Paper Awards,a 1984 IEEE Centennial Medal, an IEEE Third Millenium Medal, and a Fuzzy Systems Pioneer Award (2008) from the IEEE Computational Intelligence Society.

Deep Learning and the Representation of Natural Data

Yann LeCun
New York University, http://yann.lecun.com

Abstract – The combined emergence of very large datasets, powerful parallel computers, and new machine learning methods, has enabled the deployment of highly-acurate computer perception systems, and is opening the door to a wide deployment of AI systems.

A key component in systems that can understand natural data is a module that turns the raw data into an suitable internal representation. But designing and building such a module, often called a feature extractor, requires a considerable amount of engineering efforts and domain expertise.

The main objective of 'Deep Learning' is to come up with learning methods that can automatically produce good representations of data from labeled or unlabeled samples. Deep learning allows us to construct systems that are trained end to end, from raw inputs to ultimate output. Instead of having a separate feature extractor and predictor, deep architectures have multiple stages in which the data is represented hierarchically: features in successive stages are increasingly global, abstract, and invariant to irrelevant transformations of the input.

The convolutional network model (ConvNet) is a particular type of deep architecture that is somewhat inspired by biology, and consist of multiple stages of filter banks, interspersed with non-linear operations, and spatial pooling. ConvNets, have become the record holder for a wide variety of benchmarks and competition, including object detection, localization, and recognition in image, semantic image segmentation and labeling (2D and 3D), acoustic modeling for speech recognition, drug design, handwriting recognition, biological image segmentation, etc.

The most recent speech recognition and image understanding systems deployed by Facebook, Google, IBM, Microsoft, Baidu, NEC and others use deep learning, and many use convolutional networks. Such systems use very large and very deep ConvNets with billions of connections, trained using backpropagation with stochastic gradient, with heavy regularization. But many new applications require the use of unsupervised feature learning methods. A number of methods based on sparse auto-encoder will be presented.

Several applications will be shown through videos and live demos, including a category-level object recognition system that can be trained on the fly, a system that can label every pixel in an image with the category of the object it belongs to (scene parsing), a pedestrian detector, and object localization and detection systems that rank first on the ImageNet Large Scale Visual Recognition Challenge data. Specialized hardware architecture that run these systems in real time will also be described.

Biography – Yann LeCun is Director of AI Research at Facebook, and Silver Professor of Data Science, Computer Science, Neural Science, and Electrical Engineering at New York University, affiliated with the NYU Center for Data Science, the Courant Institute of Mathematical Science, the Center for Neural Science, and the Electrical and Computer Engineering Department.

He received the Electrical Engineer Diploma from Ecole Supérieure d'Ingénieurs en Electrotechnique et Electronique (ESIEE), Paris in 1983, and a PhD in Computer Science from Université

Pierre et Marie Curie (Paris) in 1987. After a postdoc at the University of Toronto, he joined AT&T Bell Laboratories in Holmdel, NJ in 1988. He became head of the Image Processing Research Department at AT&T Labs-Research in 1996, and joined NYU as a professor in 2003, after a brief period as a Fellow of the NEC Research Institute in Princeton. From 2012 to 2014 he directed NYU's initiative in data science and became the founding director of the NYU Center for Data Science. He was named Director of AI Research at Facebook in late 2013 and retains a part-time position on the NYU faculty.

His current interests include AI, machine learning, computer perception, mobile robotics, and computational neuroscience. He has published over 180 technical papers and book chapters on these topics as well as on neural networks, handwriting recognition, image processing and compression, and on dedicated circuits and architectures for computer perception. The character recognition technology he developed at Bell Labs is used by several banks around the world to read checks and was reading between 10 and 20% of all the checks in the US in the early 2000s. His image compression technology, called DjVu, is used by hundreds of web sites and publishers and millions of users to access scanned documents on the Web. Since the mid 1980's he has been working on deep learning methods, particularly the convolutional network model, which is the basis of many products and services deployed by companies such as Facebook, Google, Microsoft, Baidu, IBM, NEC, AT&T and others for image and video understanding, document recognition, human-computer interaction, and speech recognition.

LeCun has been on the editorial board of IJCV, IEEE PAMI, and IEEE Trans. Neural Networks, was program chair of CVPR'06, and is chair of ICLR 2013 and 2014. He is on the science advisory board of Institute for Pure and Applied Mathematics, and has advised many large and small companies about machine learning technology, including several startups he co-founded. He is the lead faculty at NYU for the Moore-Sloan Data Science Environment, a $36M initiative in collaboration with UC Berkeley and University of Washington to develop data-driven methods in the sciences. He is the recipient of the 2014 IEEE Neural Network Pioneer Award.

A Historical Perspective on Computational Intelligence in N-player Games

George H. Burgin
Natural Selection, Inc.

Abstract – Evolutionary algorithms have a long history of application in two-person zero-sum games. These efforts began as solutions to aerospace engineering problems but were then extended to players that do not adhere to minimax strategies, non-zero-sum games, and to problems where players could cooperate. This lecture will discuss these early applications, typically in the context of aerial pursuit and evasion with role reversal. In light of requirements for high-fidelity simulation environments, evolutionary programming was able to develop strategies and tactical maneuvers that assisted in the training of human expert pilots in the form of an "Adaptive Maneuvering Logic." This technology formed the basis of the first real-time adaptive gaming simulator using evolutionary computation, competing at the level of human experts despite being deployed on a CDC 6600 mainframe computer (the most advanced computer system available at the time). The lecture will review these early successful approaches and conclude with thoughts on present and future applications of computational intelligence to games. The talk will be accompanied by a special guest lecturer who will describe applications of evolutionary algorithms in selected modern game settings including leisure and finance.

Biography – Dr. George H. Burgin has more than five decades of experience in the areas of artificial intelligence, applied mathematics, and communications theory. He received the degree of Diplom Ingenieur from the Swiss Federal Institute of Technology and earned a Ph.D. from the same institute. In the 1960s, Dr. Burgin worked with Dr. Lawrence J. Fogel at Decision Science Incorporated and performed some of the first research in applying evolutionary computation to games and system identification. He was previously a senior staff member at Titan's System Division, where he applied evolutionary programming, expert systems, and neural networks for flight control and mission planning systems. Dr. Burgin's research interests include application of neural networks and evolutionary algorithms to solve real-life problems and the development of efficient adaptive linear and nonlinear filters. Dr. Burgin received the 2014 IEEE CIS Evolutionary Computation Pioneer award.

Invited Lectures

Learning through Deterministic Assignment of Hidden Parameters

Zongben Xu
Xi'an Jiaotong University

Abstract – Supervised learning boils down to determining hidden and bright parameters in a parameterized hypothesis space based on a finite number of input-output pairs. The hidden parameters determine the hidden predictors or nonlinear mechanism of an estimator, while the bright parameters characterize how the hidden predictors are linearly combined or the linear mechanism. In traditional learning paradigm, the hidden and bright parameters are not distinguished and trained simultaneously in one learning process. Such an one-stage learning (OSL) brings a benefit of theoretical analysis but suffers severely from the very high computation burden. To overcome this difficulty, a two-stage learning scheme (TSL), featured by learning through random assignment for hidden parameters (LRHP), that assigns randomly the hidden parameters in the first stage and determines the bright parameters by solving a linear least squares problem in the second stage. LRHP works well in many applications but suffers from the uncertainty problem: its performance can be guaranteed only in a certain statistical expectation sense.

In this talk we propose a new TSL scheme: the learning through deterministic assignment of hidden parameters (LDHP). Borrowed from an approximate solution of the classical hard sphere problem and by applying the homeomorphism principle in mathematics, we suggest to deterministically take the hidden parameters as the tensor product of the minimal Riesz energy points on sphere and the best packing points in an interval. We theoretically show that with such deterministic assignment of hidden parameters, LDHP almost shares the same generalization performance with that of OSL, i.e., it does not degrade the generalization capability of OSL. Thus LDHP provides a very effective way of overcoming both the high computation burden of OSL and the uncertainty difficulty in LRHP. We present a series of simulation and application examples to support such advantages and outperformance of LDHP, as compared with the typical OSL algorithm -- Support Vector Regression (SVR) and the typical LRHP algorithm -- Extreme Learning Machine (ELM). The study conducted in this paper paves a new road to simply and more efficiently solve supervised learning problems.

Biography – Zongben Xu was born in 1955. He received his Ph.D. degrees in mathematics from Xi'an Jiaotong University, China, in 1987. He now serves as Vice President of Xi'an Jiaotong University, the Chief Scientist of National Basic Research Program of China (973 Project), and Director of the Institute for Information and System Sciences of the university. He is owner of the National Natural Science Award of China in 2007，and winner of CSIAM Su Buchin Applied Mathematics Prize in 2008. He delivered a 45 minute talk on the International Congress of Mathematicians 2010. He was elected as member of Chinese Academy of Sciences in 2011. His current research interests include intelligent information processing and applied mathematics.

Recent Advances in Fuzzy Modeling and Control: When Nonlinearities Met Fuzzy Logic

Kazuo Tanaka
The University of Electro-Communications, Japan

Abstract – This talk presents an overview of recent advances in fuzzy modeling and control of nonlinear systems. A number of system-theoretical approaches, ranging from convex linear matrix inequality (LMI) based design to non-convex sum-of-squares (SOS) based synthesis, are discussed in detail. These approaches are characterized by their salient treatments of nonlinearities enabled by a progression of fuzzy modeling frameworks from the Takagi-Sugeno fuzzy model to polynomial fuzzy systems. The research covered in this talk has been conducted in our laboratory at the University of Electro-Communications (UEC), Tokyo, Japan, in collaboration with Prof. Hua O. Wang and his laboratory at Boston University, Boston, USA.

Today, there exists a large body of literature on fuzzy model-based control using LMIs. The first part of this talk presents a synopsis of LMI-based fuzzy control methodologies. A key feature of LMI-based approaches is that they result in simple, natural and effective design procedures as alternatives or supplements to other nonlinear control techniques that require special and rather involved knowledge. The LMI-based design approaches entail obtaining numerical solutions by convex optimization methods such as the interior point method.

The second part of this talk focuses on SOS-based approaches. Though LMI-based approaches have enjoyed great success and popularity, there still exist a large number of design problems that either cannot be represented in terms of LMIs, or the results obtained through LMIs are sometimes conservative. A post-LMI framework is the SOS-based approaches for control of nonlinear systems using polynomial fuzzy systems and controllers, which includes the well-known Takagi-Sugeno fuzzy systems and controllers as special cases.

The last part of the talk discusses non-convex approaches in SOS-based approaches. To obtain a polynomial fuzzy controller by solving design conditions efficiently, non-convex design conditions are transformed to convex design conditions. However the transformation often results in some challenging issues in SOS-based approaches. Conversely, non-convex design conditions can avoid the transformation problems, but it is difficult to solve non-convex design conditions efficiently. To this end, this talk presents a most recent result on an efficient numerical technique, the so-called path following technique, to deal with non-convex design conditions.

Throughout the talk, it will be reflected upon how to contend with nonlinearities via enabling fuzzy modeling paradigms coupled with system-theoretical approaches in development of toolkits for control of nonlinear systems.

Biography – Kazuo Tanaka is currently a Professor in Department of Mechanical Engineering and Intelligent Systems at the University of Electro-Communications, Tokyo, Japan. He received his Ph.D. in Systems Science from Tokyo Institute of Technology in 1990. He was a Visiting Scientist in Computer Science at University of North Carolina at Chapel Hill in 1992 and 1993.

He received the Best Young Researchers Award from the Japan Society for Fuzzy

Theory and Systems in 1990, the Outstanding Papers Award at the 1990 Annual NAFIPS Meeting in Toronto, Canada, in 1990, the Outstanding Papers Award at the Joint Hungarian-Japanese Symposium on Fuzzy Systems and Applications in Budapest, Hungary, in 1991, the Best Young Researchers Award from the Japan Society for Mechanical Engineers in 1994, the Outstanding Book Awards from the Japan Society for Fuzzy Theory and Systems in 1995, 1999 IFAC World Congress Best Poster Paper Prize in 1999, 2000 IEEE Transactions on Fuzzy Systems Outstanding Paper Award in 2000, the Best Paper Selection at 2005 American Control Conference in Portland, USA, in 2005, the SICE Award at RoboCup Japan Open 2010, Osaka, Japan, in 2010, Best in class Autonomy Award at RoboCup 2011 Japan Open in Osaka, Japan, in 2011, the Best Paper Award at 2013 IEEE International Conference on Control System, Computing and Engineering (ICCSCE 2013) in Penang, Malaysia, in 2013, the Best Paper Finalist at 2013 International Conference on Fuzzy Theory and Its Applications (iFUZZY2013) in Taipei, Taiwan, in 2013.

He served as Vice Chair of IEEE International Symposium on Intelligent Control (ISIC09) (in 2009 IEEE Multi-conference on Systems and Control), Saint Petersburg, Russia, in 2009. He served also as Chair of Task Forces on Fuzzy Control Theory and Application, IEEE Computational Intelligence Society Fuzzy Systems Technical Committee. He is currently serving as an Associate Editor for Automatica and for the IEEE Transactions on Fuzzy Systems, and is on the IEEE Control Systems Society Conference Editorial Board.

His research interests include fuzzy systems control, nonlinear systems control, robotics, brain-machine interface and their applications. He published many papers in these areas, as well as 17 books, including: Fuzzy Control Systems Design and Analysis: A Linear Matrix Inequality Approach (Wiley-Interscience, 2001). His publications currently report over 5,500 citations according to Web of Science, with an h-index of 23.

Evolutionary Multi-Objective Optimization (EMO): Two Eventful Decades and Beyond

Kalyan Deb

Michigan State University, kdeb@egr.msu.edu

Abstract – Multi-objective optimization deals with solving problems having multiple conflicting objectives and results in, not one, but multiple trade-off solutions. No wonder, evolutionary computation methods with their population approach dominated multi-objective problem solving for the past two decades. Besides new and efficient EMO algorithms, the field diversified into different directions including significant applications, theoretical advancements and fruitful collaboration with other contemporary fields. In this talk, we draw a time line of major events that fueled the research and practice of EMO. Based on the past and current EMO accomplishments, we shall then discuss major future goals and challenges that promise to keep the field attracting, rewarding and alive.

Biography – Kalyanmoy Deb is Koenig Endowed Chair Professor at Electrical and Computer Engineering in Michigan State University, USA. Prof. Deb's research interests are in evolutionary optimization and their application in optimization, modeling, and machine learning. He was awarded 'Honorary Doctorate Degree' from University of Jyvaskyla, 'Wiley Practice Prize', 'Infosys Prize', 'TWAS Prize' in Engineering Sciences, 'CajAstur Mamdani Prize', 'Distinguished Alumni Award' from IIT Kharagpur, 'Edgeworth-Pareto' award, and Bhatnagar Prize in Engineering Sciences. He is Fellow of IEEE, ASME, ISGEC, and three science academies in India. He has published 365+ research papers with Google Scholar citation of 60,000+ with h-index 82. He is in the editorial board on 18 major international journals.

Innovations and Open Problems in Supervised, Unsupervised and Reinforcement Learning

Donald Wunsch
Missouri University of Science & Technology

Abstract – Some design principles and innovations in various learning modalities are reviewed, particularly in relation to value gradients, time scales and data reduction. Diverse application examples will be discussed. A few open problems of interest will be presented with their motivations.

Biography – Donald Wunsch is the Mary K. Finley Missouri Distinguished Professor at Missouri University of Science & Technology (Missouri S&T). He is also a newly appointed Master in the DeTao Group of China. Earlier employers were: Texas Tech University, Boeing, Rockwell International, and International Laser Systems. His education includes: Executive MBA– Washington University in St. Louis, Ph.D., Electrical Engineering–University of Washington (Seattle), M.S., Applied Mathematics (same institution), B.S., Applied Mathematics–University of New Mexico, and Jesuit Core Humanities Honors Program, Seattle University. Key research contributions are: Clustering; Adaptive Resonance and Reinforcement Learning architectures, hardware and applications; Neurofuzzy regression; Traveling Salesman Problem heuristics; Robotic Swarms; and Bioinformatics. He is an IEEE Fellow and previous INNS President, INNS Fellow and Senior Fellow 2007–2013, and served as IJCNN General Chair, and on several Boards, including the St. Patrick's School Board, IEEE Neural Networks Council, International Neural Networks Society, and the University of Missouri Bioinformatics Consortium, Chaired the Missouri S&T Information Technology and Computing Committee as well as the Student Design and Experiential Learning Center Board. He has produced 16 Ph.D. recipients in Computer Engineering, Electrical Engineering, and Computer Science; has attracted over $8 million in sponsored research; and has over 300 publications including nine books. His research has been cited over 8200 times.

Linguistic Dynamic Systems for Computational Societies: A Clouds-based Neuro-Fuzzy Approach

Fei-Yue Wang
Institute of Automation, Chinese Academy of Sciences

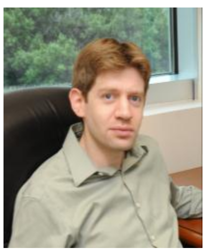
Abstract – Linguistic Dynamic Systems (LDS) was first introduced in early 1990s for modeling, analysis and control of complex human-machine systems. One of the most distinguished features of LDS is its unique knowledge representation mechanism, which is modular, structural, adaptive and understandable in linguistic terms that human can easily understand. In this report, we will present a few new developments of applying LDS for various problems in social computing and management of complex systems, especially socioeconomic systems. In those studies, LDS consist of interactive agents specified by linguistic fuzzy rules for sensing, transition, and decision-making. A distributed modular approach has been constructed to map rules for agents at local sites into structural equivalent neural networks that can be implemented via cloud computing for learning and optimization at remote sites and then deployed back to the local sites as revised rules after refinement. We will point out that there is a natural link between our approach and the method used in the current popular deep learning technique, but with different mechanism for knowledge representation. Finally, a case of study of using LDS for large scale dynamic data mining and social sentiment analytics will be described and discussed.

Biography – Fei-Yue Wang received his Ph.D. in Computer and Systems Engineering from Rensselaer Polytechnic Institute, Troy, New York in 1990. Dr. Wang has been a researcher, educator, and practitioner of intelligent and complex systems for over 30 years. He joined the University of Arizona in 1990 and became a Professor and Director of the Robotics and Automation Lab (RAL) and Program in Advanced Research for Complex Systems (PARCS). In 1999, he found the Intelligent Control and Systems Engineering Center at the Institute of Automation, Chinese Academy of Sciences (CAS), Beijing, China, under the support of the Outstanding Oversea Chinese Talents Program from the State Planning Council and "100 Talent Program" from CAS , and in 2002, was appointed as the Director of the Key Lab of Complex Systems and Intelligence Science, CAS. From 2006 to 2010, he was Vice President for research, education, and academic exchanges at the Institute of Automation, CAS. In 2011, he was supported by the "1000 Talent Program" and became the Director of the State Key Laboratory of Management and Control for Complex Systems. Dr. Wang has published extensively in modeling, analysis, control and management of complex systems. His current research is focused in methods and applications for parallel systems and social computing. He was the Founding Editor-in-Chief of the International Journal of Intelligent Control and Systems from 1995 to 2000, the Series on Intelligent Control and Intelligent Automation from 1996 to 2004, and IEEE Intelligent Transportation Systems, and the EiC of IEEE Intelligent Systems from 2009 to 2012. Currently, he is the EiC of IEEE Transactions on ITS. Since 1997, he has served as General or Program Chair of more than 20 IEEE, INFORMS, ACM, ASME conferences. He was the President of IEEE ITS Society from 2005 to 2007, Chinese Association for Science and Technology (CAST, USA) in 2005, and the American Zhu Kezhen Education Foundation from 2007-2008. Since 2008, he is the Vice President and Secretary General of Chinese Association of Automation. Dr. Wang is member of Sigma Xi and an elected Fellow of IEEE, INCOSE, IFAC, ASME, and AAAS. In 2007, he received the 2nd Class National Prize in Natural Sciences of China and awarded the Outstanding Scientist by ACM for his work in intelligent control and social computing. He received IEEE ITS Outstanding Application and Research Awards in 2009 and 2011, respectively.

How Innovative New Games Can Reinvigorate the Field of Computational Intelligence

Ken Stanley
University of Central Florida

Abstract – While computational intelligence enjoys a long history of applications to games, in recent years researchers have begun to build increasingly sophisticated and professional-quality video games around novel computational intelligence technologies. These platforms serve as both major promotional and education opportunities for the field, as well as serious research platforms. They also contribute to a creative culture of experimentation and invention that motivates students to contribute. This talk highlights the transformative potential of these kinds of projects with the hope of inspiring other researchers in computational intelligence to consider creating games around their approaches as well. I will illustrate how such projects can succeed and even sometimes impact the game industry through my own experience building several such platforms over the years (including NERO, Galactic Arms Race, Picbreeder, and Petalz). The http://aigameresearch.org website will also be highlighted as an initiative to showcase to the world the best such work has to offer.



Biography – Kenneth O. Stanley is an associate professor in the Department of Electrical Engineering and Computer Science at the University of Central Florida. He received a B.S.E. from the University of Pennsylvania in 1997 and received a Ph.D. in 2004 from the University of Texas at Austin. He is an inventor of the Neuroevolution of Augmenting Topologies (NEAT), HyperNEAT, and novelty search algorithms for evolving complex artificial neural networks. His main research contributions are in neuroevolution (i.e. evolving neural networks), generative and developmental systems (GDS), coevolution, computational intelligence for video games, and interactive evolution. He has won best paper awards for his work on NEAT, NERO, NEAT Drummer, FSMC, HyperNEAT, novelty search, and Galactic Arms Race. He is an associate editor of IEEE Transactions on Computational Intelligence and AI in Games, on the editorial board of Evolutionary Computation journal, and on the ACM SIGEVO Executive Committee. He is also a co-founder and the editor-in-chief of http://aigameresearch.org.

Intelligent Feedback Control for Operation of Complex Industrial Processes

Tianyou Chai
Northeastern University

Abstract – Process control should aim at not only ensuring controlled variables to best follow their set points, but also requiring the optimal control for the operation of the whole plant to make the operational indices (e.g. quality, efficiency and consumptions during the production phase) into their targeted ranges. It also requires that operational indices for quality and efficiency should be enhanced as high as possible, whilst the indices related to consumptions are kept at their lowest possible level. Based upon a survey on the existing operational optimization and control methodologies, this talk presents a data-driven hybrid intelligent feedback control for operation of complex industrial processes and a hybrid simulation system. Simulations and industrial applications to a roasting process for the hematite ore mineral processing industry are used to demonstrate the effectiveness of the proposed method. Issues for future research on the optimal operational control for complex industrial processes are outlined in the final section.

Biography – Prof. Tianyou Chai is Member of Chinese Academy of Engineering, IFAC Fellow and IEEE Fellow. He received his Ph. D. degree in Control Theory and Engineering from Northeastern University in 1985 and became a Professor in 1988 in the same university. He is the founder and Director of the Automation Research Center, which became a National Engineering and Technology Research Center and a State Key Laboratory. He has served as a member of IFAC Technical Board and Chairman of IFAC Coordinating Committee on Manufacturing and Instrumentation during 1996-1999. He serves as director of Department of Information Sciences of National Natural Science Foundation of China (NSFC) since 2010. He is a distinguished visiting fellow of The Royal Academy of Engineering (UK) and an invitation fellow of Japan Society for the Promotion of Science (JSPS).

Prof. Chai's research interests include modeling, control, optimization and integrated automation of complex industrial processes. He has published two monographs and 148 peer reviewed international journal papers and around 255 international conference papers. He has also been invited to deliver more than 30 plenary speeches in international conferences of IFAC and IEEE.

He has made a number of important contributions in control technologies and applications. These include multivariable adaptive decoupling control theory and applications, innovative intelligent decoupling control technology, the development of a hybrid intelligent optimal control technique for automation systems, which has been successfully applied to process industries such as iron and steal, minerals processing, nonferrous metals, and electric power, resulting in enormous economic benefits.

For his contributions, he has won numerous awards including three National Science and Technology Progress Awards, one National Technological Innovation Award, the Technological Science Progress Award from Ho Leung Ho Lee Foundation in 2002, the Science and Technology Honor Prize of Liaoning Province in 2003, and honor of "National Advanced Worker" in 2005, respectively. He received the 2007 Industry Award for Excellence in Transitional Control Research from IEEE Multiple-conference on Systems and Control. In addition, he won 2010 Yang Jia-Chi Science and Technology Award from Chinese Association of Automation.

Fuzzy Dynamic Programming: A Step Towards Cognitive Dynamic Programming?

Janusz Kacprzyk
Systems Research Institute, Polish Academy of Sciences

Abstract – This presentation concerns dynamic programming which is, roughly speaking, an optimal procedure to solve problems that have a multistage character, that is, when decisions over some, finite or infinite horizon, are to be taken at some consecutive stages, notably time related. It has been developed just after World War II by Richard E. Bellman, one of the most famous control and systems theorists, and – more generally – one of the most famous applied mathematicians. Since its inception, dynamic programming has been extensively applied to solve a multitude of problems in a wide array of areas, exemplified by operations research, mathematical economics, control, systems analysis, etc. Basically, the essence of dynamic programming, which boils down to finding an optimal policy, refers to simplifying a complicated problem by breaking it down into simpler subproblems in a recursive manner, all that in an extremely simple and effective way, though not always efficient (the infamous curse of dimensionality). This is clearly closely related to how humans approach problem solving, and also how they evaluate control trajectories among which an optimal one is to be found.

That power of dynamic programming and its universal importance and applicability has inspired Ballman and Zadeh to propose in their 1970 article the use of fuzzy sets, notably via fuzzy constraints on controls and fuzzy goals on states/outputs, to extend the basic dynamic programming model into fuzzy dynamic programming. That foundational model has then been extended to, e.g., fuzzy termination time, fuzzy systems under control, infinite termination time, etc. by Kacprzyk, summarized in his books of 1983, 1997 and 2001. Moreover, the use of neural networks as models of such multistage decision/control processes has been proposed by Francelin, Gomide and Kacprzyk, and then in a more comprehensive modeling and optimization setting by Jun Wang.

Kacprzyk's models of fuzzy dynamic programming have been applied to solve many real life problems, notably related to the modeling and planning/programming of sustainable regional development, and it turned out that an inherent "softness" and human consistency of fuzzy dynamic programming, which results just from a softer definition of constraints, goals and a (separable, i.e. via some proper aggregation operators) performance function is not enough. In particular, the human planners or decision makers have tended to perform a much more sophisticated assessment of the development trajectory (the consecutive decisions/controls and outputs) that by its simple efficiency (a high value). In particular, they have advocated a more sophisticated assessment of variability, stability, balancedness of consecutive controls (expenditures) over time and subject area, etc. Clearly, this all was imprecisely specified and could be well represented by fuzzy sets. This all has implied a necessity to reformulate the basic fuzzy dynamic programming model, and not all resulting performance function have had a separable form to use fuzzy dynamic programming. In fact, the model developed could have been better termed a fuzzy modeling based dynamic programming, and actually its first version was quoted as one most successful examples of fuzzy modeling in L.C. Thomas (Ed.): Golden developments in operational research, Pergamon Press, 1987. The model has been extended along that line.

In the presentation, we will first present that comprehensive fuzzy dynamic programming based model, emphasizing the role of human specific judgments, assessments, perceptions, etc. We will basically follow the human centric system paradigm in the spirit of MIT (notably advocated by the late Michael Dertouzos), though in decision/control perspective.

Then, we will show that it would be beneficial for the field in question, i.e. fuzzy dynamic programming, or more generally the formulation and solution of multistage decision and control models meant for human centric systems, to find some more general paradigm. It should make it possible to better reflect the very process of developing a multistage model by the human, but even more so a better way to evaluate trajectories (decisions/controls and outputs), and find best (possibly optimal) solutions.

As a first alternative in the above search for a proper paradigm, we will consider as a potential candidate

cognitive informatics introduced by Yingxu Wang. It is basically a multidisciplinary field within informatics, or computer science, that is based on results of cognitive and information sciences, and which deals with human information processing mechanisms and processes and their decision theoretic, engineering, applications in broadly perceived computing, including our recursive fuzzy dynamic programming scheme. The purpose is to develop and implement technologies to facilitate and extend the information acquisition, comprehension and processing capacity of humans to overcome some cognitive difficulties related to the presence of the human being as a crucial part of the system (in our case, an inherently optimization focused problem), exemplified by abilities like a limited comprehension, memorizing, learning, choice and decision making, satisfaction with partial truth, allowing for not perfect solutions, etc. These issues are considered and solved using tools and techniques derived from many areas like psychology, behavioral science, neuroscience, artificial intelligence, linguistics, etc. In our case, we will concentrate on some cognitive informatics type elements that mostly have been inspired by psychology and behavioral sciences, as our problem is inherently related to human judgments and perceptions, but we will mention some inspirations from neuroscience, notably along the lines of neuroeconomics.

The new fuzzy dynamic programming models presented, in which the above human specific aspects will be shown and analyzed, will be illustrated for clarity on a sustainable regional development considered in terms of expenditures, subsidies, life qualities, etc.

We hope that our proposal can be a first step towards what might be termed cognitive fuzzy dynamic programming which might both shed a new light on the very essence of how multistage decisions are made in human centric problems, how inherently imprecise human judgments should be reflected, and how to reflect human evaluations of time evolution of performance indicators so that a "meaningful" optimal solution be obtained.

Biography – Janusz Kacprzyk graduated from the Department of Electronic, Warsaw University of Technology in Warsaw, Poland with M.Sc. in automatic control, his Ph.D. in systems analysis and D.Sc. ("habilitation") in computer science from the Polish Academy of Sciences. He is Professor of Computer Science at the Systems Research Institute, Polish Academy of Sciences, Professor of Computerized Management Systems at WIT – Warsaw School of Information Technology, and Professor of Automatic Control at PIAP – Industrial Institute of Automation and Measurements, in Warsaw, Poland, and Department of Electrical and Computer Engineering, Cracow University of Technology, in Cracow, Poland. He is Honorary Foreign Professor at the Department of Mathematics, Yli Normal University, Xinjiang, China, and Visiting Scientist at the RIKEN Brain Research Institute in Tokyo, Japan. He is Full Member of the Polish Academy of Sciences, and Foreign Member of the Bulgarian Academy of Sciences and Spanish Royal Academy of Economic and Financial Sciences (RACEF). He is Fellow of IEEE and of IFSA.

He was a frequent visiting professor in the USA, Italy, UK, Mexico and China. His main research interests include the use of computational intelligence, notably fuzzy logic, in decisions, optimization, control, data analysis and data mining, with applications in databases, ICT, mobile robotics, etc.

He is the author of 5 books, (co)editor of 70 volumes, (co)author of 500 papers. He is the editor in chief of 6 book series at Springer, and of 2 journals, and a member of editorial boards of more than 40 journals. He is a member, a member of Adcom (Administrative Committee) of IEEE CIS, of Award Committee of IEEE CIS, and a Distinguished Lecturer of IEEE CIS.

He received many awards, notably: The 2006 IEEE CIS Pioneer Award in Fuzzy Systems, The 2006 Sixth Kaufmann Prize and Gold Medal for pioneering works on soft computing in economics and management, and The 2007 Pioneer Award of the Silicon Valley Section of IEEE CIS for contribution in granular computing and computing in words, and Award of the 2010 Polish Neural Network Society for exceptional contributions to the Polish computational intelligence community, IFSA 2013 Award for outstanding academic contributions and life time achievement in the field of fuzzy systems, and a continuous support of IFSA, WAC (World Automation Congress) 2014 Lifetime Achievement Award in Soft Computing.

Currently he is President of the Polish Society for Operational and Systems Research and Past President of IFSA (International Fuzzy Systems Association).

Jason Lohn

No info is available at the time when the program book is printed.

The EU Human Brain Project – A Systematic Path from Data to Synthesis

Karlheinz Meier
Heidelberg University, http://karlheinzmeier.eu

Abstract – The Human Brain Project in Europe joins 80 research groups in an unprecedented effort to understand function and dysfunction of the human brain and to design and materialize brain derived computing architectures. The novelty of the HBP approach lies in the consistent use of ICT based methods to aggregate neuroscience and medical data, to perform closed-loop brain simulations on high performance supercomputers and to build and operate non-von Neumann computer architectures systematically derived from biological knowledge. The lecture will provide an overview of the project objectives and present first results from simulations and neuromorphic emulation experiments in HBP.

Biography – Karlheinz Meier is a professor of experimental physics at Heidelberg University in Germany. He received his PhD in 1984 from Hamburg University. For more than 30 years he worked in experimental particle physics, contributing to several experiments at the CERN and DESY laboratories. He designed and implemented a large-scale data selection system for an LHC experiment at CERN: Since 2005 he has shifted his interest towards custom hardware implementations of neural circuits. He has initiated and led 2 major European initiatives in the field (FACETS and BrainScaleS) and is currently co-director of the Human Brain Project

Fuzzy Real-time Leakage Supervisory System for Fluid Transportation Pipeline Networks: New Methods and Applications

Huaguang Zhang

Northeastern University, zhanghuaguang@mail.neu.edu.cn

Abstract – Pipelines has becomes one of the main transportation manners in nowadays, therefore, the security of the pipelines becomes more and more important. In this talk, we will give out a solution for the problem of how to supervise fluid transportation networks, especially, how to find weak leakage and localize the leaking point when a weak leakage happens. To this aim, there are five difficulties should be solved:

(i) How to get the measured signals so that the weak leakage signal is kept but the noise is filtered out?

(ii) How to transform the weak leakage signals into the detectable information flow?

(iii) How to discern the weak leakage from the other operating mode?

(iv) How to locate the weak leakage point?

(v) How to construct a networked real-time leaking monitoring and command platform?

For each problem stated above, we give out a complete solution, which includes both theory analysis and system realization. We use the blind source decouple method to extract the desired signals; we use chaos theory and the fuzzy hyperbolic tangent model to transform the weak signals into detectable signals; we use the generalized fuzzy hyperbolic tangent model to discern the operating mode; we use the wavelet transform to localize the weak leakage point; and at last, we construct a global supervisory and command platform for the pipeline networks. The proposed supervisory system has been proven to be very effective through years of practice.

Biography – Huaguang Zhang (SM'04) received the B.S. degree and the M.S. degree in control engineering from Northeast Dianli University of China, Jilin City, China, in 1982 and 1985, respectively. He received the Ph.D. degree in thermal power engineering and automation from Southeast University, Nanjing, China, in 1991.

He joined the Department of Automatic Control, Northeastern University, Shenyang, China, in 1992, as a Postdoctoral Fellow for two years. Since 1994, he has been a Professor and Head of the Institute of Electric Automation, School of Information Science and Engineering, Northeastern University, Shenyang, China. His main research interests are fuzzy control, stochastic system control, neural networks based control, nonlinear control, and their applications. He has authored and coauthored over 280 journal and conference papers, six monographs and co-invented 90 patents.

Dr. Zhang is the Chair of the Adaptive Dynamic Programming & Reinforcement Learning Technical Committee in IEEE Computational Intelligence Society. He is an Associate Editor of AUTOMATICA, IEEE TRANSACTIONS ON NEURAL NETWORKS, IEEE TRANSACTIONS ON CYBERNETICS, and NEUROCOMPUTING. He was an Associate Editor of IEEE TRANSACTIONS ON FUZZY SYSTEMS (2008-2013). He was awarded the Outstanding Youth Science Foundation Award from the National Natural Science Foundation of China in 2003. He was named the Cheung Kong Scholar by the Education Ministry of China in 2005. He is also the recipient of the IEEE Transactions on Neural Networks Outstanding Paper Award in 2012.

Computation, the Missing Ingredient in Classical Economics

Edward Tsang
University of Essex, http://www.bracil.net/edward

Abstract – In classical economics, computation is taken for granted. The implicit assumption is that, being perfectly rational, everyone can find optimal solutions given the information available. Moreover, everyone can find solutions as good as others, in more or less the same time. If these assumptions were true, then much of computer science and computational intelligence are irrelevant. In this talk, I shall explain that computational intelligence has a major role to play in economics. I shall argue that reinforcement learning, the principle behind evolutionary computation and neural network, is a better alternative to the perfect rationality assumption. Search methods and machine learning are crucial to modeling. Only when computation costs are included could economic models be brought closer to reality.

Biography – Edward Tsang holds a first degree in Finance and an MSc and PhD degree in Computer Science. He is the Director of Centre for Computational Finance and Economic Agents (CCFEA), an interdisciplinary research center which he co-founded in October 2002. He has international reputation in artificial intelligence. He is well known for his research in constraint satisfaction (a branch of combinatorial optimization for decision support and scheduling) and computational finance and economics. His book on constraint satisfaction is the most cited literature on the subject. He founded the Technical Committee in Computation Finance and Economics in IEEE's Computational Intelligence Society in 2004. Edward Tsang's research is highly industry-relevant. He has given consultation to GEC Marconi, British Telecom, Honda Europe, Causeway, Old Mutual Asset Managers, Allianz RAS and other organizations.

IEEE WCCI 2014 Tutorial Schedule

Time/ Room	No.1 Conference Room	No.2 Conference Room	No.3 Conference Room	No.4 Conference Room	No.5 Conference Room	No.6 Conference Room	No.7 Conference Room
08:00 - 10:00	T5A2: Decomposition and Cooperative Coevolution Techniques for Large Scale Global Optimization	T7A1: Black Box Complexity: A Complexity Theory for Evolutionary Computation	T3A1: The Emerging "Big Dimensionality"	T2A1: Slow Feature Analysis for Curiosity Driven Agents	T5A1: Probabilistic Fuzzy Systems	T1A1: Prototype-based Methods: Mathematical Foundations, interpretability, and data visualization	T8A1: Evolutionary Algorithms for Industrial Optimization Problems: Challenges and Lessons Learned
Speakers	Xiaodong Li	Benjamin Doerr	Ivor Tsang and Yew Soon Ong	Matthew Luciw, Varun Raj Kompella and Juergen Schmidhuber	S. M. Vieira, U. Kaymak, AND J. M. Sousa	Barbara Hammer	Bogdan Filipic
10:30 - 12:30	T3A2: Spiking Neural Networks for Machine Learning and Predictive Data Modeling: Methods, Systems, Applications	T7A2: A Gentle Introduction to the Time Complexity Analysis of Evolutionary Algorithms	T6A1: Computational Intelligence and Games	T2A2: Smart Grid, Renewable Energy, and Data Processing	T8A2: Cultural Algorithms: Theory and Practice	T4A2: An Introduction to Bioinformatics and Computational Biology for Computational Intelligence Researchers	T6A2: Introduction to Evolutionary Game Theory
Speakers	Nikola Kasabov and Nathan Scott	Pietro S. Oliveto	Simon M. Lucas and Clare Bates Congdon	Anthony Kuh, Danilo Mandic, and Dona Nakafuji	Robert G. Reynolds	Clare Bates Congdon and Jeffrey A. Thompson	Garrison W. Greenwood
14:00 - 16:00	T1P1: The Mind-Brain and Big Data	T2P1: Evaluation of Computational Intelligence Decision Makers: Receiver Operating Characteristic, Jackknife, Bootstrap and Other Statistical Methodologies	T5P1: Applications of Markov Chain Methodology in Evolutionary Computation	T3P1: Computational Intelligence for Decoding Brain's Motor Cortical Functions	T7P1: Recent Advances in Fitness Landscapes	T4P1: Fuzzy Rough Data Mining with WEKA Suite	T8P1: Theory of Swarm Intelligence
Speakers	Leonid I. Perlovsky	David Brown	Boris Mitavskiy and Jun He	Jennie Si	Hendrik Richter	Richard Jensen, Neil Mac Parthalain and Qiang Shen	Dirk Sudholt
16:20 - 18:20	T1P2: Large-scale Deep Learning	T7P2: A Brief Introduction of Diversity-Preservation Methodologies in Evolutionary Optimization	T8P2: Differential Evolution: Recent advances	T6P2: Creative Evolutionary Algorithms	T4P2: Type-2 Fuzzy Sets and Systems with Application to Perceptual Computing	T2P2: Computational Intelligence Approaches to Identification and Early Diagnosis of Memory Diseases	T3P2: Autonomous Learning
Speakers	Xuewen Chen and Cindy Lin	Giovanni Squillero and Alberto Tonda	P. N. Suganthan and S. Das	Francisco Fernandez de Vega	Jerry Mendel	Francesco Carlo Morabito	Plamen Angelov, Jose Principe, and Asim Roy

Program at a Glance of IEEE WCCI 2014

Time/Room	308	305A	305B	305C	305D	305E	303		201A	201B	201C	201D	203A	203B	203C	203D	Posters Areas
Sunday, July 6th, 2014																	
08:00-18:20	Tutorials, Institute of Automation, Chinese Academy of Sciences (95 Zhong Guan Cun East Rd, Beijing 100190, Tel: 82544761)																
14:00-20:00	Registration, BICC																
18:30-20:30	Welcome reception, Hall #1, BICC																
Monday, July 7th, 2014																	
08:00-08:30	**Congress opening ceremony**, Hall #1, BICC																
08:30-09:30	**Plenary lecture 1**: *Some Recent Work in Computational Intelligence for Software Engineering* , **Xin Yao**, Hall #1, BICC, Chair: Derong Liu																
09:30-10:00	Coffee break: 2nd floor and 3rd floor, exhibit areas																
10:00-11:00	**Plenary lecture 2**: *Toward Cognitive Integration of Prosthetic Devices* , **Jose C. Principe**, Hall #1, BICC, Chair: Jennie Si																
11:00-12:00	**Plenary lecture 3**: *Type-2 Fuzzy Sets and Systems: Some Questions and Answers* , **Jerry M. Mendel**, Hall #1, BICC, Chair: Dimitar Filev																
12:00-13:30	Lunch, BICC																
Time/Room	**308**	**305A**	**305B**	**305C**	**305D**	**305E**	**303**		**201A**	**201B**	**201C**	**201D**	**203A**	**203B**	**203C**	**203D**	**Posters Areas**
13:30-15:30	Special Session: MoN1-1 Neuromorphic Science & Technology for Augmented Human Performance in Cybersecurity	Special Session: MoN1-2 Artificial Neural Networks and Learning Techniques towards Intelligent Transport Systems	Special Session: MoN1-3 Computational Intelligence for Cognitive Fault Diagnosis	MoN1-4 Deep Learning	MoN1-5 Ensemble and Meta Learning	MoN1-6 Time Series Analysis I	MoN1-7 Approximate Dynamic Programming and Reinforcement Learning		Special Session: MoF1-1 Fuzzy Decision-Making: Consensus and Missing Preferences I	Special Session: MoF1-2 Lattice Computing	MoF1-3 Fuzzy Control & Intelligent Systems I	MoF1-4 Fuzzy Logic and Fuzzy Set Theory I	Special Session: MoE1-1 Computational Intelligence and Games	Special Session: MoE1-2 Memetic Computing	Special Session: MoE1-3 Evolutionary Computer Vision	Special Session: MoE1-4 Theoretical Foundations of Bio-inspired Computation	
15:30-16:00	Coffee break: 2nd floor and 3rd floor, exhibit areas																
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Tuesday, July 8th, 2014																	
08:30-09:30	**Plenary panel 1**: *CI-related Research Funding* , Hall #2, BICC, Chair: Marios Polycarpou																
09:30-10:00	Coffee break: 2nd floor and 3rd floor, exhibit areas																
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11:00-12:00	**IJCNN Invited lecture 2**: *Innovations and Open Problems in Supervised, Unsupervised and Reinforcement Learning* , **Don Wunsch II**, Hall #2A, BICC, Chair: Haibo He						**FUZZ-IEEE Invited lecture 2**: *Linguistic Dynamic Systems for Computational Societies: A Clouds-based Neuro-Fuzzy Approach* , **Fei-Yue Wang**, Hall #2B, BICC, Chair: Plamen Angelov					**IEEE CEC Invited lecture 2**: *How Innovative New Games Can Reinvigorate the Field of Computational Intelligence* , **Ken Stanley**, Hall #2C, BICC, Chair: Ying Tan					
12:00-13:30	Lunch, BICC																
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13:30-15:30	Special Session: TuN1-1 International Workshop on Computational Energy Management in Smart Grids I	Special Session: TuN1-2 Intelligent Vehicle Systems	Special Session: TuN1-3 Biologically Inspired Computational Vision	TuN1-4 Real World Applications II	TuN1-5 Feedforward Neural Networks II	TuN1-6 Supervised Learning I	Special Session: TuF1-5 Advances to Type-2 Fuzzy Logic Control		Special Session: TuF1-1 Computing with Words in Decision Making	Special Session: TuF1-2 Time Series: Advanced Methods of Analysis and Forecast	Special Session: TuF1-3 Fuzzy Computer Vision and Biometrics	TuF1-4 Approximate Reasoning and Theory	Special Session: TuE1-1 Evolutionary Computation for Planning and Scheduling	Special Session: TuE1-2 Swarm Intelligence for Real-World Engineering Optimization	Special Session: TuE1-3 Complex Networks and Evolutionary Computation	Special Session: TuE1-4 Evolutionary Algorithms with Statistical and Machine Learning Techniques	
15:30-16:00	Coffee break: 2nd floor and 3rd floor, exhibit areas																
16:00-18:00	Special Session: TuN2-1 International Workshop on Computational Energy Management in Smart Grids II	Special Session: TuN2-2 Neural Networks Applied to Vision and Robotics I	Special Session: TuN2-3 Autonomous Learning	TuN2-4 Machine Learning: Complexity and Optimization	TuN2-5 Feature Extraction and Intelligent Systems	TuN2-6 Supervised Learning II	Industrial Session: TuF2-5 CI on Big Data and Social Networks		Special Session: TuF2-1 Computing with Words and Fuzzy Natural Language Processing	Special Session: TuF2-2 Applications of Type-2 Fuzzy Systems	Special Session: TuF2-3 Computational Intelligence for Human-centred Applications	TuF2-4 Fuzzy Control and Intelligent Systems II	Special Session: TuE2-1 Nature-Inspired Constrained Optimization	Special Session: TuE2-2 Computational Intelligence in Bioinformatics	Special Session: TuE2-3 Single Objective Numerical Optimization I	Special Session: TuE2-4 Data Mining and Machine Learning Meet Evolutionary Computation	15:30-18:00 Poster session II IJCNN (level 3) FUZZ-IEEE (level 2) IEEE CEC (level 2)
18:30-20:30	Student reception (all students are invited), Banquet Hall, 2nd floor, Continental Grand Hotel																
Wednesday, July 9th, 2014																	
08:30-09:30	**Plenary panel 2**: *Is "Publish or Perish" Causing "Death" of Science?* Hall #2, BICC, Chair: Nik Pal																
09:30-10:00	Coffee break: 2nd floor and 3rd floor, exhibit areas																
10:00-11:00	**Plenary lecture 4**: *Deep Learning and the Representation of Natural Data* , **Yann LeCun**, Hall #2, BICC, Chair: Cesare Alippi																
11:00-12:00	**Plenary lecture 5**: *A Historical Perspective on Computational Intelligence in N-player Games,* **George H. Burgin**, Hall #2, BICC, Chair: Carlos Coello Coello																
12:00-13:30	Lunch, BICC																
Time/Room	**308**	**305A**	**305B**	**305C**	**305D**	**305E**	**303**	**311A**	**201A**	**201B**	**201C**	**201D**	**203A**	**203B**	**203C**	**203D**	**Posters Areas**
13:30-15:30	Special Session: WeN1-1 International Workshop on Computational Energy Management in Smart Grids III	Special Session: WeN1-2 International Workshop on Advances in Learning from/with Multiple Learners	Special Session: WeN1-3 Machine Learning for Computer Vision I	WeN1-4 Intelligent Systems and Applications	WeN1-5 Unsupervised Learning and Clustering I	WeN1-6 Supervised and Semi-Supervised Learning	Industrial Session: WeN1-7 CI on Smart Grid and Energy Efficiency	WeI1-1 Intel Special Session on Big Data Analytics	Special Session: WeF1-1 Human Symbiotic Systems I	Special Session: WeF1-2 Methods and Applications of Fuzzy Cognitive Maps	WeF1-3 Real World Applications	WeF1-4 Fuzzy Pattern Recognition & Image Processing	WeE1-1 Multi-Objective Evolutionary Algorithms I	WeE1-2 Evolutionary Games and Multi-Agent Systems	Special Session: WeE1-3 Hybrid Evolutionary Computational Methods for Complex Optimization Problems	Special Session: WeE1-4 Large Scale Global Optimization	
15:30-16:00	Coffee break: 2nd floor and 3rd floor, exhibit areas																
16:00-18:00	Special Session: WeN2-1 Plenary and Discussion Session of International Workshops	Special Session: WeN2-2 Learning and Optimization in Multi-criteria Dynamic and Uncertain Environments	Special Session: WeN2-3 Machine Learning for Computer Vision II	WeN2-4 Spiking Neural Networks I	WeN2-5 Unsupervised Learning and Clustering II	WeN2-6 Dynamics of Neural Systems	Industrial Session: WeN2-7 CI on Control Systems	Special Session: WeC2-1 CIS and WCCI Competition Session	Special Session: WeF2-1 Human Symbiotic Systems II	Special Session: WeF2-2 Modalities of Fuzzy Signatures in Knowledge Representation	WeF2-3 Hybrid Fuzzy Systems	WeF2-4 Fuzzy Decision Making and Decision Support Systems I	Special Session: WeE2-1 Evolutionary Computation in Dynamic and Uncertain Environments	Special Session: WeE2-2 Intelligent Design for Reliable Cloud Computing	Special Session: WeE2-3 Single Objective Numerical Optimization II	WeE2-4 Learning Classifier Systems	15:30-18:00 Poster session III IJCNN (level 3) FUZZ-IEEE (level 2) IEEE CEC (level 2)
18:30-21:30	Banquet (Entertainment & Award Ceremony), Ballroom A+B+C, China National Convention Center (7 Tianchen East Rd, Beijing 100105, Tel: 84373300)																

Thursday, July 10th, 2014																	
08:30-09:30	**Panel 3 (IJCNN)**, *Brain Research* , Hall #2A, BICC, Chair: Jose Principe						**Panel 4 (FUZZ-IEEE)**, *Big Data and Machine Learning* , Hall #2B, BICC, Chair: Jerry Mendel					**Panel 5 (IEEE CEC)**, *Evolutionary Multi-Criterion Optimization* , Hall #2C, BICC, Chair: Kalyan Deb					
09:30-10:00	Coffee break: 2nd floor and 3rd floor, exhibit areas																
10:00-11:00	**IJCNN Invited lecture 3**: *Intelligent Feedback Control for Operation of Complex Industrial Processes* , **Tianyou Chai**, Hall #2A, BICC, Chair: Gary Yen						**FUZZ-IEEE Invited lecture 3**: *Fuzzy Dynamic Programming: A Step Towards Cognitive Dynamic Programming?* **Janusz Kacprzyk**, Hall #2B, BICC, Chair: Faa-Jeng Lin					**IEEE CEC Invited lecture 3**: **Jason Lohn**, Hall #2C, BICC, Chair: Carlos Coello Coello					
11:00-12:00	**IJCNN Invited lecture 4**: *The EU Human Brain Project – A Systematic Path from Data to Synthesis* , **Karlheinz Meier**, Hall #2A, BICC, Chair: Akira Hirose						**FUZZ-IEEE Invited lecture 4**: *Fuzzy Real-time Leakage Supervisory System for Fluid Transportation Pipeline Networks: New Methods and Applications* , **Huaguang Zhang**, Hall #2B, BICC, Chair: Chin-Teng Lin					**IEEE CEC Invited lecture 4**: *Computation, the Missing Ingredient in Classical Economics* , **Edward Tsang**, Hall #2C, BICC, Chair: Hisao Ishibuchi					
12:00-13:30	Lunch, BICC																
Time/Room	**308**	**305A**	**305B**	**305C**	**305D**	**305E**	**303**		**201A**	**201B**	**201C**	**201D**	**203A**	**203B**	**203C**	**203D**	**Posters Areas**
13:30-15:30	Special Session: ThN1-1 Architectures and Theories of the Brain	Special Session: ThN1-2 Hybrid Neural Intelligent Systems	Special Session: ThN1-3 Ensemble Systems and Machine Learning	ThN1-4 Reinforcement and Hybrid Learning	ThN1-5 Models of Perception, Cognition and Coordination	ThN1-6 Recurrent Neural Networks	Industrial Session: ThE1-5 Computational Intelligence on Predictive Maintenance and Optimization		Special Session: ThF1-1 Hand Skill Recognition and Transfer	Special Session: ThF1-2 Hybridisations, Extensions, and High-Order Fuzzy Sets	ThF1-3 Fuzzy Clustering	ThF1-4 Fuzzy Systems Modelling and Identification	ThE1-1 Ant Colony Optimization	ThE1-2 Opposition-Based Learning and Differential Evolution	ThE1-3 Genetic Programming	ThE1-4 Heuristics, Metaheuristics and Hyper-heuristics I	
15:30-16:00	Coffee break: 2nd floor and 3rd floor, exhibit areas																15:30-18:00 Poster session IV IJCNN (level 3) FUZZ-IEEE (level 2) IEEE CEC (level 2)
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08:10-10:10	Special Session: FrN1-1 Concept Drift, Domain Adaptation & Learning in Dynamic Environments II	Special Session: FrN1-2 Neural Networks Applied to Vision and Robotics II	Special Session: FrN1-3 Complex-Valued Neural Networks	FrN1-4 Visual Systems	FrN1-5 Data Analysis and Pattern Recognition	FrN1-6 Hybrid Architectures and Learning	FrE1-5 Multimodal Optimization and Population Initialization		Special Session: FrF1-1 Handling Uncertainties in Big Data by Fuzzy Systems	Special Session: FrF1-2 Evolutionary Fuzzy Systems	FrF1-3 Fuzzy Control and Intelligent Systems III	FrF1-4 Fuzzy Data Mining and Forecasting	FrE1-1 Differential Evolution	FrE1-2 Process Mining and Data Mining	FrE1-3 Estimation of Distribution Algorithms and Machine Learning	FrE1-4 Evolutionary Computation Theory and Parameter Optimization	
10:10-10:30	Coffee break: 2nd floor and 3rd floor, exhibit areas																
10:30-12:30	Special Session: FrN2-1 Computational Intelligence Algorithms for Digital Audio Applications	Special Session: FrN2-2 Intelligent Computing for Complex & Big Data Analysis in Health and Biomedical Informatics	Special Session: FrN2-3 Data-Driven Adaptive Dynamic Programming	FrN2-4 Data Mining and Knowledge Discovery	FrN2-5 Large Scale, Associative and Self-Organizing Networks	FrN2-6 Self-Organizing Maps	FrE2-5 Robotics and Engineering Applications		Special Session: FrF2-1 Recent Advances in Fuzzy-Model-Based Control Design and Analysis I	Special Session: FrF2-2 Software for Soft Computing I	Special Session: FrF2-3 Fuzzy Interpolation	FrF2-4 Fuzzy Decision Making and Decision Support Systems II	FrE2-1 Multi-Objective Evolutionary Algorithms III	FrE2-2 Numerical Optimization	FrE2-3 Coevolution and Collective Behavior	FrE2-4 Biometrics, Bioinformatics and Biomedical Applications	
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13:30-15:30	Special Session: FrN3-1 Intelligent Adaptive Fault Tolerant Control and Optimization	Special Session: FrN3-2 Cognitive Computing and Neuro-Cognitive Robots	FrN3-3 Unsupervised Learning and Clustering	FrN3-4 Cognition, Bio-Inspired and Biomorphic Systems	FrN3-5 Machine Learning and Applications I	FrN3-6 Brain-Machine Interfaces	FrE3-5 Real-World Applications II		Special Session: FrF3-1 Recent Advances in Fuzzy-Model-Based Control Design and Analysis II	Special Session: FrF3-2 Software for Soft Computing II	Special Session: FrF3-3 Theory of Type-2 Fuzzy Systems	Special Session: FrF3-4 Brain and Physiological Computation for Affective Computing	FrE3-1 Large-Scale Problems and Real-World Applications	FrE3-2 Evolvable Hardware and Software and Genetic Programming	FrE3-3 Swarm Intelligence	FrE3-4 Heuristics, Metaheuristics and Hyper-Heuristics II	
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Tomislav Bacek, Dubravko Majetic and Danko Brezak

5:00PM *Coarse and Fine Learning in Deep Networks*
Anthony Knittel and Alan Blair

5:20PM *Constrained Extreme Learning Machine: A Novel Highly Discriminative Random Feedforward Neural Network*
Wentao Zhu, Jun Miao and Laiyun Qing

5:40PM *Self-Learning Recursive Neural Networks for Structured Data Classification*
Bouchachia Abdelhamid

4:00PM *Data-Aware Remaining Time Prediction of Business Process Instances*
Mirko Polato, Alessandro Sperduti, Andrea Burattin and Massimiliano de Leoni

4:20PM *Forecasting Hourly Electricity Load Profile Using Neural Networks*
Mashud Rana, Irena Koprinska and Alicia Troncoso

4:40PM *Time Series Forecasting via Weighted Combination of Trend and Seasonality Respectively with Linearly Declining Increments and Multiple Sine Functions*
Wenchao Lao, Ying Wang, Chen Peng, Chengxu Ye and Yunong Zhang

5:00PM *A Factor - Artificial Neural Network Model for Time Series Forecasting: The Case of South Africa*
Ali Babikir and Henry Mwambi

5:20PM *A Neural Network Based Approach to Support the Market Making Strategies in High-Frequency Trading*
Everton Silva, Douglas Castilho, Adriano Pereira and Humberto Brandao

5:40PM *A Monte Carlo Strategy for Structured Multiple-Step-Ahead Time Series Prediction*
Gianluca Bontempi

4:00PM *Face Recognition through a Chaotic Neural Network Model*
Luis Fernando Martins Carlos Jr. and Joao Luis Rosa

4:20PM *Confidence Factor and Feature Selection for Semi-Supervised Multi-Label Classification Methods*
Fillipe Rodrigues, Anne Canuto and Araken Santos

4:40PM *Applying the Self-Training Semi-Supervised Learning in Hierarchical Multi-Label Methods*
Araken Santos and Anne Canuto

5:00PM *Sampling-Based Learning Control for Quantum Discrimination and Ensemble Classification*
Chunlin Chen, Daoyi Dong, Bo Qi, Ian Petersen and Herschel Rabitz

5:20PM *An Improved Extreme Learning Machine with Adaptive Growth of Hidden Nodes Based on Particle Swarm Optimization*
Min-Ru Zhao, Jian-Ming Zhang and Fei Han

5:40PM *Structural Representation and Reasoning in a Hybrid Cognitive Architecture*
John Licato, Ron Sun and Selmer Bringsjord

1:30PM *Exploring the Performance of Non-Negative Multi-Way Factorization for Household Electrical Seasonal Consumption Disaggregation*
Marisa Figueiredo, Bernardete Ribeiro and Ana de Almeida

1:50PM *Community Detection Based on Local Topological Information in Power Grid*
Zengqiang Chen, Zheng Xie and Qing Zhang

2:10PM *A Heuristic to Generate Initial Feasible Solutions for the Unit Commitment Problem*
Yi Sun, Y.S. Albert Lam and O.K. Victor Li

3:10PM *A Google Approach for Computational Intelligence in Big Data*
Andreas Antoniades and Clive Cheong Took

1:30PM *Explicit Feature Mapping via Multi-Layer Perceptron and Its Application to Mine-Like Objects Detection*
Hang Shao and Nathalie Japkowicz

1:50PM *Compressing VG-RAM WNN Memory for Lightweight Applications*
Edilson de Aguiar, Avelino Forechi, Lucas de Paula Veronese, Mariella Berger, Alberto F. De Souza, Claudine Badue and Oliveira-Santos Thiago

2:10PM *Data Driven Modeling for UGI Gasification Process via a Variable Structure Genetic BP Neural Network*
Shida Liu, Zhongsheng Hou and Chenkun Yin

2:30PM *MofN Rule Extraction from Neural Networks Trained with Augmented Discretized Input*
Rudy Setiono, Arnulfo Azcarraga and Yoichi Hayashi

2:50PM *Optimizing Configuration of Neural Ensemble Network for Breast Cancer Diagnosis*
Peter McLeod and Brijesh Verma

3:10PM *An Efficient Conjugate Gradient Based Multiple Optimal Learning Factors Algorithm of Multilayer Perceptron Neural Network*
Xun Cai, Kanishka Tyagi and Michael T Manry

1:30PM *Imputation of Missing Data Supported by Complete p-Partite Attribute-Based Decision Graphs*
Joao Bertini, Maria Nicoletti and Liang Zhao

1:50PM *An Asymmetric Stagewise Least Square Loss Function for Imbalanced Classification*
Guibiao Xu, Bao-Gang Hu and Jose Principe

2:10PM *An Analysis Based on F-Discrepancy for Sampling in Regression Tree Learning*
Cristiano Cervellera, Mauro Gaggero and Danilo Maccio

2:30PM *Coupled Fuzzy k-Nearest Neighbors Classification of Imbalanced Non-IID Categorical Data*
Chunming Liu, Longbing Cao and Philip S Yu

2:50PM *Wind Power Forecasting- An Application of Machine Learning in Renewable Energy*
Jawad Ali, Gul Muhammad Khan and Sahibzada Ali Mahmud

3:10PM *Signature Identification via Efficient Feature Selection and GPU-Based SVM Classifier*
Bernardete Ribeiro, Noel Lopes and Joao Goncalves

P301 *Hopfield Neural Network for Seismic Velocity Picking*
Kou-Yuan Huang and Jia-Rong Yang

P302 *Deep Neural Networks for Mandarin Tone Recognition*
Mingming Chen, Zhanlei Yang and WenJu Liu

P303 *An Adaptive Multiclass Boosting Algorithm for Classification*
Shixun Wang, Peng Pan and Yansheng Lu

P304 *Animal Group Behavioral Model with Evasion Mechanism*
Zhiping Duan and Xiaodong Gu

P305 *Superpixel Appearance and Motion Descriptors for Action Recognition*
Xuan Dong, Ah-Chung Tsoi and Sio-Long Lo

P306 *Structured Sparse Coding Method for Infrared Small Target Detection in Video Sequence*
Chunwei Yang, Huaping Liu, Shouyi Liao and Shicheng Wang

P307 *Human Activity Recognition Using Smart Phone Embedded Sensors: A Linear Dynamical Systems Method*
Wen Wang, Huaping Liu, Lianzhi Yu and Fuchun Sun

P308 *Effect of Spectrum Occupancy on the Performance of a Real Valued Neural Network Based Energy Detector*
Adeiza James Onumanyi, Elizabeth Onwuka, Abiodun Musa Aibinu, Okechukwu Ugweje and Momoh Jimoh Salami

P309 *Scale Invariant Feature Transform Flow Trajectory Approach with Applications to Human Action Recognition*
Jia-Tao Zhang, Ah-Chung Tsoi and Sio-Long Lo

P310 *An Effective Criterion for Pruning Reservoir's Connections in Echo State Networks*
Simone Scardapane, Gabriele Nocco, Danilo Comminiello, Michele Scarpiniti and Aurelio Uncini

P311 *Similarity-Balanced Discriminant Neighborhood Embedding*
Chuntao Ding, Li Zhang, Yaping Lu and Shuping He

P312 *Stability of a Neutral Delay Neuron System in the Critical Case*
Xiaofeng Liao

P313 *Further Enhancements in WOM Algorithm to Solve the Local Minimum and Flat-Spot Problem in Feed-Forward Neural Networks*
Chi Chung Cheung, Sin Chun Ng, Andrew K Lui and Sean Shensheng Xu

P314 *Extending Dynamic SOMs to Capture Incremental Changes in Data*
Thushan Ganegedara, Lasindu Vidana Pathiranage, Ruwan Gunarathna, Buddhima Wijeweera, Amal Shehan and Damminda Alahakoon

P315 *Application of Fuzzy Systems in the Control of a Shunt Active Power Filter with Four-Leg Topology*
Edson Junior Acordi, Ivan Nunes Silva and Ricardo Quadros Machado

P316 *Highly Sensitive Weak Signal Acquisition Method for GPS/Compass*
Song Li, Qing-ming Yi, Min Shi and Qing Chen

P317 *Mining User Tasks from Print Logs*
Xin Li, Lei Zhang, Ping Luo, Enhong Chen, Guandong Xu, Yu Zong and Chu Guan

P318 *Adaptive Backstepping-Based Nonlinear Disturbance Observer for Fin Stabilizer System*
Weiwei Bai and Tieshan Li

P319 *Multiagent Evolutionary Design of Flexible Beta Basis Function Neural Tree*
Marwa Ammar, Souhir Bouaziz, Adel M. Alimi and Ajith Abraham

P320 *Similarity Michaelis-Menten Law Pre-Processing Descriptor for Face Recognition*
Suli Ji, Baochang Zhang, Dandan Du and Jianzhuang Liu

P321 *Single Image Super-Resolution via Learned Representative Features and Sparse Manifold Embedding*
Liao Zhang, Shuyuan Yang, Jiren Zhang and Licheng Jiao

P322 *Facial Expression Recognition under Random Block Occlusion Based on Maximum Likelihood Estimation Sparse Representation*
S. S. Liu, Y. Zhang and K. P. Liu

P323 *Non-Singular Terminal Sliding Mode Control for Landing on Asteroids Based on RBF Neural Network*
K. P. Liu, F. X. Liu, S. S. Liu and Y. C. Li

P324 *Automatic Forest Species Recognition Based on Multiple Feature Sets*
Marcelo N. Kapp, Rodrigo Bloot, Paulo R. Cavalin and Luiz E. S. Oliveira

P325 *Approximate Planning in POMDPs via MDP Heuristic*
Yong Lin, Xingjia Lu and Makedon Fillia

P326 *A Neural Network Left-Inversion Flux Estimation for Induction Motor Filed-Oriented Control*
Hao Zhang, Guohai Liu, Li Qu and Yan Jiang

P327 *The Transformer Fault Diagnosis Combing KPCA with PNN*
Chenxi Dai, Zhigang Liu and Yan Cui

1:50PM *An Optimal Real-Time Pricing for Demand-Side Management: A Stackelberg Game and Genetic Algorithm Approach*
Fan-Lin Meng and Xiao-Jun Zeng

2:10PM *A Simulation Based Approach to Forecast a Demand Load Curve for a Container Terminal Using Battery Powered Vehicles*
Nico Grundmeier, Norman Ihle, Axel Hahn, Claas Meyer-Barlag and Serge Runge

2:30PM *Fuzzy Power Management for Environmental Monitoring Systems in Tropical Regions*
Asher G. Watts, Michal Prauzek, Petr Musilek, Emil Pelikan and Arturo Sanchez-Azofeifa

2:50PM *Solar Radiation Forecasting under Asymmetric Cost Functions*
Seyyed A. Fatemi and Anthony Kuh

3:10PM *Selection of Weighing Functions in H-infinity Controller Design Using PBIL*
Prosser Munawa and Komla Folly

1:30PM *Feature Ensemble Learning Based on Sparse Autoencoders for Image Classification*
Yaping Lu, Li Zhang, Bangjun Wang and Jiwen Yang

1:50PM *A Review of Adaptive Feature Extraction and Classification Methods for EEG-Based Brain-Computer Interfaces*
Shiliang Sun and Jin Zhou

2:10PM *Diversity Analysis in Collaborative Clustering*
Nistor Grozavu, Guenael Cabanes and Younes Bennani

2:30PM *Solving Unbalanced Problems in Similarity Learning Using SVM Ensemble*
Peipei Xia and Li Zhang

2:50PM *Sharing Information on Extended Reachability Goals Over Propositionally Constrained Multi-Agent State Spaces*
Anderson Araujo and Carlos Henrique Ribeiro

3:10PM *A New Ensemble Method for Multi-Label Data Stream Classification in Non-Stationary Environment*
Ge Song and Yunming Ye

3:30PM *An Evaluation of the Environmental Sustainability Index in Terms of Its Prediction and Clustering Capabilities*
Tatiana Tambouratzis

1:30PM *Retinal Vessel Segmentation Based on Possibilistic Fuzzy c-means Clustering Optimised with Cuckoo Search*
Eid Emary, Hossam Zawbaa, Aboul Ella Hassanien, Gerald Schaefer and Ahmad Taher Azar

1:50PM *Large Margin Image Set Representation and Classification*
Jim Jing-Yan Wang, Majed Alzahrani and Xin Gao

2:10PM *Improving Machine Vision via Incorporating Expectation-Maximization into Deep Spatio-Temporal Learning*
Min Jiang, Yulong Ding, Goertzel Ben, Zhongqiang Huang and Fei Chao

2:30PM *Low-Rank Representation Based Action Recognition*
Xiangrong Zhang, Yang Yang, Hanghua Jia, Huiyu Zhou and Licheng Jiao

2:50PM *Interpolating Deep Spatio-Temporal Inference Network Features for Image Classification*
Yongfeng Zhang, Changjing Shang and Qiang Shen

3:10PM *A Study on Word-Level Multi-Script Identification from Video Frames*
Nabin Sharma, Umapada Pal and Michael Blumenstein

2:30PM *Hybrid Intelligent Supervision Model of Oil Wells*
Edgar Camargo and Aguilar Jose

2:50PM *Fuzzy Adaptive Cruise Control System with Speed Sign Detection Capability*
Raazi Rizvi, Shivam Kalra, Chirag Gosalia and Rahnamayan Shahryar

3:10PM *Soft Computing Techniques Based Optimal Tuning of Virtual Feedback PID Controller for Chemical Tank Reactor*
Manikandan Pandiyan

1:30PM *Practice in Analyzing Corporate Textual Data*
Phil Tian

1:50PM *Intel Hadoop and Its Use Cases*
Keith Qi

2:10PM *Big Data Foundation Platform for Video Analytics*
Albert Hu

2:30PM *Cloud based Air Quality Monitoring at Scale*
Fred Jiang

2:50PM *Big Data Foundation Platform for Video Analytics Demo*
Albert Hu

3:10PM *Cloud based Air Quality Monitoring at Scale Demo*
Fred Jiang

P501 *An Implementation of the Path Integrator Mechanism of Head Direction Cells for Bio-Mimetic Navigation*
Ankur Sinha and Jack Wang

P502 *A Legged Central Pattern Generation Model for Autonomous Gait Transition.*
Zhijun Yang, Rocha Marlon, Lima Priscila, Karamanoglu Mehmet and Franca Felipe

P503 *An Algorithm for Real-Time Object Tracking in Complex Environment*
Dongxu Gao, Jiangtao Cao and Zhaojie Ju

P504 *Robust Prediction in Nearly Periodic Time Series Using Motifs*
Woon Huei Chai, Hongliang Guo and Shen-Shyang Ho

P505 *A Hybrid Coupled k-Nearest Neighbor Algorithm on Imbalance Data*
Chunming Liu, Longbing Cao and Philip S Yu

P506 *A Consensus-Based Semi-Supervised Growing Neural Gas*
Vinicius Maximo, Marcos Quiles and Maria Nascimento

P507 *Bio-Inspired Architecture for a Reactive-Deliberative Robot Controller*
Fabian Rubilar, Maria-Jose Escobar and Tomas Arredondo

P508 *Improved Keyword Spotting System by Optimizing Posterior Confidence Measure Vector Using Feed-Forward Neural Network*
Yuchen Liu, Mingxing Xu and Lianhong Cai

P509 *Agglomerative Clustering of Defects in Ultrasonic Non-Destructive Testing Using Hierarchical Mixtures of Independent Component Analyzers*
Addisson Salazar, Jorge Igual and Luis Vergara

P510 *Completed Hybrid Local Binary Pattern for Texture Classification*
Jing-Hua Yuan, Hao-Dong Zhu, Yong Gan and De-Shuang Huang

P511 *Pitch Estimation Using Non-Negative Matrix Factorization*
Ryan Burt, Goktug Cinar and Jose Principe

P512 *On the Dynamics of the High Order Type of Neural Networks with Time Varying Coefficients and Mixed Delay*
Hajer Brahmi, Boudour Ammar, Farouk Cherif and Adel M. Alimi

P513 *DL-Pro: A Novel Deep Learning Method for Protein Model Quality Assessment*
Son Nguyen, Yi Shang and Dong Xu

P514 *Mimicking the Worm - An Adaptive Spiking Neural Circuit for Contour Tracking Inspired by C. Elegans Thermotaxis*
Ashish Bora, Arjun Rao and Bipin Rajendran

P515 *Neural Approach for Bearing Fault Classification in Induction Motors by Using Motor Current and Voltage*
W. F. Godoy, I. N. da Silva, A. Goedtel, R. H. C. Palacios and W. S. Gongora

P516 *Efficient Class Incremental Learning for Multi-Label Classification of Evolving Data Streams*
Zhongwei Shi, Yimin Wen and Yun Xue

P517 *Probabilistic Point Set Matching with Gaussian Mixture Model*
Han-Bing Qu and Jia-Qiang Wang

P518 *EEG Analysis for Cognitive Failure Detection in Driving Using Neuro-Evolutionary Synergism*
Anuradha Saha, Amit Konar, Ritambhar Burman and Atulya Nagar

P519 *Multi-Objective Optimization of a Hybrid Model for Network Traffic Classification by Combining Machine Learning Techniques*
Zuleika Nascimento, Djamel Sadok, Stenio Fernandes and Judith Kelner

P520 *Learning Motion-Difference Features Using Gaussian Restricted Boltzmann Machines for Efficient Human Action Recognition*
Tran Son, Benetos Emmanouil and Garcez Artur

P521 *Color Image Processing Based on Nonnegative Matrix Factorization with Convolutional Neural Network*
Thanh Xuan Luong, Bo-Kyeong Kim and Soo-Young Lee

P522 *Bottom-Up Model of Visual Saliency: A Viewpoint Based on Efficient Coding Hypothesis*
Hao Zhu and Biao Han

P523 *Using Self-Organizing Incremental Neural Network (SOINN) for Radial Basis Function Networks*
Jie Lu, Furao Shen and Jinxi Zhao

P524 *A New Multi-Task Learning Based Wi-Fi Location Approach Using $L_1/2$-Norm*
Wentao Mao, Haicheng Wang and Shangwang Liu

P525 *A Combined Model for Scan Path in Pedestrian Searching*
Lijuan Duan, Zeming Zhao, Wei Ma, Jili Gu, Yuanhua Qiao and Zhen Yang

P526 *Gain Parameters Based Complex-Valued BackPropagation Algorithm for Learning and Recognizing Hand Gestures*
Yuanshan Liu, He Huang and Tingwen Huang

P527 *Tension Identification of Two-Motor System Based on Neural Network Left-Inverse*
Guohai Liu, Zhennan Cai, Wenxiang Zhao, Hao Zhang, Yan Jiang and Yaojie Mi

P528 *Sideslip Angle Soft-Sensor Based on Neural Network Left Inversion for Multi-Wheel Independently Driven Electric Vehicles*
Penghu Miao, Guohai Liu, Duo Zhang, Yan Jiang, Hao Zhang and Huawei Zhou

P529 *Fast Support Vector Data Description Training Using Edge Detection on Large Datasets*
Chenlong Hu, Bo Zhou and Jinglu Hu

P530 *A Half-Split Grid Clustering Algorithm by Simulating Cell Division*
Wenxiang Dou and Jinglu Hu

P531 *Stochastic Gradient Based Iterative Identification Algorithm for a Class of Dual-Rate Wiener Systems*
Jing Leng, Junpeng Li, Changchun Hua and Xinping Guan

P532 *Wiener Model Identification of Blast Furnace Ironmaking Process Based on Laguerre Filter and Linear Programming Support Vector Regression*
Xia Xu, Changchun Hua, Yinggan Tang and Xinping Guan

P533 *Learning Features from High Speed Train Vibration Signals with Deep Belief Networks*
Jipeng Xie, Yan Yang, Tianli Li and Weidong Jin

P534 *A Neural Network and SOM Based Approach to Analyse Periodic Signals: Application to Oyster Heart-Rate Data*
Andrew Hellicar, Ashfaqur Rahman, Daniel Smith, Greg Smith and John McCulloch

P535 *Bayesian Network Scores Based Text Localization in Scene Images*
Khalid Iqbal, Xu-Cheng Yin, Hong-Wei Hao, Sohail Asghar and Hazrat Ali

P536 *Implementation of Memristive Neural Networks with Spike-Rate-Dependent Plasticity Synapses*
Yide Zhang, Zhigang Zeng and Shiping Wen

P537 *Evaluation of Active Position Detection in Vehicular Ad Hoc Networks*
Kiran Penna, Venkatesh Yalavarthi, Huirong Fu and Ye Zhu

P538 *Smart Bandwidth Management Using a Recurrent Neuro-Evolutionary Technique*
Rabia Arshad, Gul Muhammad Khan and Sahibzada Ali Mahmud

P539 *Analog Memristive Time Dependent Learning Using Discrete Nanoscale RRAM Devices*
Aniket Singha, Bhaskaran Muralidharan and Bipin Rajendran

P540 *Data Intensive Parallel Feature Selection Method Study*
Zhanquan Sun and Zhao Li

P541 *Kernel Ridge Regression Classification*
Jinrong He, Lixin Ding, Lei Jiang and Ling Ma

P542 *Causality Traces for Retrospective Learning in Neural Networks - Introduction of Parallel and Subjective Time Scales*
Katsunari Shibata

P543 *Hardware Implementation of KLMS Algorithm Using FPGA*
Xiaowei Ren, Pengju Ren, Badong Chen, Tai Min and Nanning Zheng

P544 *Parallelized Neural Networks as a Service*
Altaf Ahmad Huqqani, Erich Schikuta and Erwin Mann

4:00PM *Plenary Lecture of the International Workshops*
Paul Werbos

4:50PM *Follow-up Discussion of the Two International Workshops*
Stefamo Squartini and Nistor Grozavu

4:00PM *The Scalarized Multi-Objective Multi-Armed Bandit Problem: An Empirical Study of Its Exploration vs. Exploitation Tradeoff*
Saba Yahyaa, Madalina Drugan and Bernard Manderick

4:20PM *Accelerating Learning in Multi-Objective Systems through Transfer Learning*
Adam Taylor, Ivana Dusparic, Edgar Galvan-Lopez, Siobhan Clarke and Vinny Cahill

4:40PM *A Novel Adaptive Weight Selection Algorithm for Multi-Objective Multi-Agent Reinforcement Learning*
Kristof Van Moffaert, Tim Brys, Arjun Chandra, Lukas Esterle, Peter Lewis and Ann Nowe

5:00PM *Multi-Objectivization of Reinforcement Learning Problems by Reward Shaping*
Tim Brys, Anna Harutyunyan, Peter Vrancx, Matthew E. Taylor, Daniel Kudenko and Ann Nowe

5:20PM *Policy Gradient Approaches for Multi-Objective Sequential Decision Making*
Simone Parisi, Matteo Pirotta, Nicola Smacchia, Luca Bascetta and Marcello Restelli

5:40PM *Multi-Objective X-Armed Bandits*
Kristof Van Moffaert, Kevin Van Vaerenbergh, Peter Vrancx and Ann Nowe

4:00PM *An Interpretable Graph-Based Image Classifier*
Filippo Maria Bianchi, Simone Scardapane, Lorenzo Livi, Aurelio Uncini and Antonello Rizzi

4:20PM *Off-Line Handwritten Thai Name Recognition for Student Identification in an Automated Assessment System*
Hemmaphan Suwanwiwat, Michael Blumenstein, Vu Nguyen and Umapada Pal

4:40PM *Feature Extraction in X-Ray Images for Hazelnuts Classification*
Khosa Ikramullah and Eros Pasero

5:00PM *A New Fuzzy Shape Context Approach Based on Multi-Clue and State Reservoir Computing*
Zhidong Deng, Kelaiti Xiao and Jing Huang

5:20PM *Structure-from-Motion Reconstruction Based on Weighted Hamming Descriptors*
Guoyu Lu, Vincent Ly and Chandra Kambhamettu

5:40PM *Local Binary Pattern Based Facial Expression Recognition Using Self-Organizing Map*
Anima Majumder, Laxmidhar Behera and Venkatesh K. Subramanian

4:00PM *Does Plasticity Promote Criticality ?*
Filipe Peliz Pinto Teixeira and Murray Shanahan

4:20PM *Evolutionary Features and Parameter Optimization of Spiking Neural Networks for Unsupervised Learning*
Marco Silva, Adriano Koshiyama, Marley Vellasco and Edson Cataldo

4:40PM *Stochastic Spiking Neural Networks at the Edge of Chaos*
J.L. Rossello, V. Canals, A. Oliver and A. Morro

5:00PM *Phase Offset Between Slow Oscillatory Cortical Inputs Influences Competition in a Model of the Basal Ganglia*
Zafeirios Fountas and Murray Shanahan

5:20PM *A Sequential Learning Algorithm for a Minimal Spiking Neural Network (MSNN) Classifier*
Shirin Dora, Sundaram Suresh and Narasimhan Sundararajan

5:40PM *Large Scale Parameter Estimation of Nonlinear Dynamic Systems: Application on Spike-In, Spike-Out Neural Models*
Alireza Dibazar

4:00PM *An Unsupervised Material Learning Method for Imaging Spectroscopy*
Johannes Jordan, Elli Angelopoulou and Antonio Robles-Kelly

4:20PM *Optimal Reduced Set for Sparse Kernel Spectral Clustering*
Raghvendra Mall, Siamak Mehrkanoon, Rocco Langone and Johan Suykens

4:40PM *An Efficient Parallel ISODATA Algorithm Based on Kepler GPUs*
Shiquan Yang, Jianqiang Dong and Bo Yuan

5:00PM *Semi-Supervised Clustering with Pairwise and Size Constraints*
Shaohong Zhang, Hau-San Wong and Dongqing Xie

5:20PM *Multivariate Multi-Scale Gaussian for Microarray Unsupervised Classification*
Amelia King, Zihua Yang and ZhengRong Yang

5:40PM *Hierarchical Linear Dynamical Systems: A New Model for Clustering of Time Series*
Goktug Cinar, Carlos Loza and Jose Principe

2:10PM *How Might the Brain Represent Complex Symbolic Knowledge?*
Ben Goertzel

2:30PM *Statistical Approach for Reconstruction of Dynamic Brain Dipoles Based on EEG Data*
Petia Georgieva, Filipe SIlva, Lyudmila Mihaylova and Nidhal Bouaynaya

2:50PM *Design of the First Neural Connectomics Challenge: From Imaging to Connectivity*
Isabelle Guyon, Demian Battaglia, Alice Guyon, Javier Orlandi, Mehreen Saeed, Jordi Soriano Fradera, Alexander Statnikov and Olav Stetter

3:10PM *A Bridge-Islands Model for Brains: Developing Numeric Circuits for Logic and Motivation*
Juyang Weng

1:30PM *Selecting and Combining Models with Self-Organizing Maps for Long-Term Forecasting of Chaotic Time Series*
Rigoberto Fonseca-Delgado and Pilar Gomez-Gil

1:50PM *Impulsive Synchronization of Coupled Switched Neural Networks with Impulsive Time Window*
Xin Wang, Chuandong Li, Tingwen Huang and Xiaofeng Liao

2:10PM *Vibrate Synchronizing Function Neural Network Model - Its Backgrounds*
Yoshitsugu Kakemoto and Shinichi Nakasuka

2:30PM *Neural Networks for Runtime Verification*
Alan Perotti, Artur d'Avila Garcez and Guido Boella

1:30PM *Towards Generating Random Forests via Extremely Randomized Trees*
Le Zhang, Ye Ren and P. N. Suganthan

1:50PM *Reservoir Computing Optimization with a Hybrid Method*
Anderson Sergio and Teresa Ludermir

2:10PM *An Empirical Analysis of Ensemble Systems in Cancellable Behavioural Biometrics: A Touch Screen Dataset*
Marcelo Damasceno de Melo and Anne Canuto

2:30PM *Ensemble Learning for Keyword Extraction from Event Descriptions*
Pedro Geadas, Ana Alves and Bernardete Ribeiro

2:50PM *Ensembles Of Evolutionary Extreme Learning Machines through Differential Evolution and Fitness Sharing*
Tiago Lima and Teresa Ludermir

1:30PM *Unmanned Aerial Vehicles (UAV) Heading Optimal Tracking Control Using Online Kernel-Based HDP Algorithm*
Fuxiao Tan, Derong Liu, Xinping Guan and Bin Luo

1:50PM *Scalarization-Based Pareto Optimal Set of Arms Identification Algorithms*
Madalina Drugan and Ann Nowe

2:10PM *Approximate Model-Assisted Neural Fitted Q-Iteration*
Thomas Lampe and Martin Riedmiller

2:30PM *Explore to See, Learn to Perceive, Get the Actions for Free: SKILLABILITY*
Varun Kompella, Marijn Stollenga, Matthew Luciw and Juergen Schmidhuber

2:50PM *Correntropy Kernel Temporal Differences for Reinforcement Learning Brain Machine Interfaces*
Jihye Bae, Luis Sanchez Giraldo, Joseph Francis and Jose Principe

3:10PM *PROPRE: PROjection and PREdiction for Multimodal Correlations Learning. An Application to Pedestrians Visual Data Discrimination.*
Mathieu Lefort and Alexander Gepperth

P708 *Moving Towards Accurate Monitoring and Prediction of Gold Mine Underground Dam Levels*
Ali Hasan and Bhekisipho Twala

P709 *Convolutional Deep Belief Networks for Feature Extraction of EEG Signal*
Yuanfang Ren and Yan Wu

P710 *Newton's Method Backpropagation for Complex-Valued Holomorphic Multilayer Perceptrons*
Diana La Corte and Yi Ming Zou

P711 *Fuzzy c-Means Clustering with a New Regularization Term for Image Segmentation*
Guangpu Shao

P712 *Direct Adaptive Neural Network Control of a Class of Nonlinear Systems*
Baobin Miao and Tieshan Li

P713 *Hybrid SVM/HMM Architectures for Statistical Model-Based Voice Activity Detection*
YingWei Tan, WenJu Liu, Wei Jiang and Hao Zheng

P714 *Novel Stability Criteria of T-S Fuzzy Hopfield Neural Networks with Time-Varying Delays and Uncertainties*
Caigen Zhou, Xiaoqin Zeng and Jianjiang Yu

P715 *A Collaborative Filtering Framework Based on Local and Global Similarities with Similarity Tie-Breaking Criteria*
Andre Lopes, Ricardo Prudencio and Byron Bezerra

P716 *SVM Classification for Imbalanced Data Sets Using Conformal Kernel Transformations*
Yong Zhang, Panpan Fu and Wenzhe Liu

P717 *Analysis of Disease Association and Susceptibility for SNP Data Using Emotional Neural Networks*
Xiao Wang, Qinke Peng and Tao Zhong

P718 *Artificial Immune System Application for Solving Dynamic Optimization Problems*
Zhijie Li, Yuanxiang Li, Kuang Li and Fei Yu

P719 *Synchronization Control of Hybrid-Coupled Heterogeneous Complex Networks*
Jianqiang Hu, Jinling Liang and Jinde Cao

P720 *Robust LS-SVR Based on Variational Bayesian and Its Applications*
Kefeng Ning, Min Liu, Mingyu Dong and Zhansong Wu

P721 *Label Propagation and Soft-Similarity Measure for Graph Based Constrained Semi-Supervised Learning*
Zhao Zhang, Mingbo Zhao and Tommy W.S. Chow

P722 *An Improved RBM Based on Bayesian Regularization*
Guangyuan Pan and Junfei Qiao

P723 *On the Cooperative Observability of a Continuous-Time Linear System on an Undirected Network*
Henghui Zhu, Kexin Liu, Jinhu Lu, Zongli Lin and Yao Chen

P724 *Robust Bilinear Matrix Recovery by Tensor Low-Rank Representation*
Zhao Zhang and Mingbo Zhao

P725 *Using Chou's Amphiphilic Pseudo-Amino Acid Composition and Extreme Learning Machine for Prediction of Protein-Protein Interactions*
Qiao-Ying Huang, Zhu-Hong You, Shuai Li and Zexuan Zhu

P726 *Joint Multiple Dictionary Learning for Tensor Sparse Coding*
Yifan Fu, Junbin Gao, Yanfeng Sun and Xia Hong

P727 *Dependent Stotchastic Blockmodels*
Eunsil Gim, Juho Lee and Seungjin Choi

P728 *Splitted Neural Networks for Better Performance of Antenna Optimization*
Linh Ho Manh, Francesco Grimaccia, Marco Mussetta and Riccardo E. Zich

P729 *Learning Features with Structure-Adapting Multi-View Exponential Family Harmoniums*
Kang Yoonseop and Choi Seungjin

P730 *Outdoor Scene Understanding Using SEVI-BOVW Model*
Haibing Zhang, Shirong Liu and Chaoliang Zhong

P731 *Global Exponential Stability of Delayed Hopfield Neural Network on Time Scale*
Xuehui Mei and Haijun Jiang

P732 *Application of Neural Networks to Evaluate Experimental Data of Galvanic Zincing*
Peter Michal, Jan Pitel, Alena Vagaska and Ivo Bukovsky

P733 *Iris Liveness Detection Methods in the Mobile Biometrics Scenario*
Ana F. Sequeira, Juliano Murari and Jaime S. Cardoso

P734 *Nonnegative Shifted Tensor Factorization in Time Frequency Domain*
Qiang Wu, Ju Liu, Fengrong Sun, Jie Li and Andrzej Cichocki

P735 *Modeling of Vertical Mill Raw Meal Grinding Process and Optimal Setting of Operating Parameters Based on Wavelet Neural Network*
Xiaofeng Lin and Zhe Qian

P736 *Kernel Robust Mixed-Norm Adaptive Filtering*
Jin Liu, Hua Qu, Badong Chen and Wentao Ma

P737 *Soft-Constrained Nonnegative Matrix Factorization via Normalization*
Long Lan, Naiyang Guan, Xiang Zhang, Dacheng Tao and Zhigang Luo

P738 *Latency-Based Probabilistic Information Processing in a Learning Feedback Hierarchy*
Alexander Gepperth

P739 *Improving the Genetic-Algorithm-Optimized Wavelet Neural Network for Stock Market Prediction*
Yu Fang, Kamaladdin Fataliyev, Lipo Wang, Xiuju Fu and Yaoli Wang

P740 *Optimal Software Maintenance Policy Based on Reliability and Risk*
Xiaoping Wang, Fang Zhou and Yi Shen

P741 *Forecasting Electricity Consumption in South Africa: ARMA, Neural Networks and Neuro-Fuzzy Systems*
Lufuno Marwala and Twala Bhekisipho

P742 *PVis - Partitions' Visualizer: Extracting Knowledge by Visualizing a Collection of Partitions*
Katti Faceli, Tiemi Sakata, Andre Carvalho and Marcilio de Souto

4:00PM *Adaptively Weighted Support Vector Regression for Financial Time Series Prediction*
Zhijie Li, Yuanxiang Li, Fei Yu and Dahai Ge

4:20PM *A Higher-Order Fuzzy Neural Network for Modeling Financial Time Series*
Massimo Panella, Luca Liparulo and Andrea Proietti

4:40PM *Beating The S-and-P 500 Index - A Successful Neural Network Approach*
Mininder Sethi, Philip Treleaven and Sebastian Del Bano Rollin

5:00PM *Stock Volatility Prediction Using Multi-Kernel Based Extreme Learning Machine*
Feng Wang, Zhiyong Zhao, Xiaodong Li and Fei Yu

5:20PM *Augmented Neural Networks for Modelling Consumer Indebtness*
Alexandros Ladas, Jon Garibaldi, Rodrigo Scarpel and Uwe Aickelin

5:40PM *A New Investment Strategy Based on Data Mining and Neural Networks*
Chang Liu and Hafiz Malik

4:00PM *Locally Linear Embedding Algorithm Based on OMP for Incremental Learning*
Yiqin Leng, Li Zhang and Jiwen Yang

4:20PM *Hidden Markov Models Based Dynamic Hand Gesture Recognition with Incremental Learning Method*
Meng Hu, Furao Shen and Jinxi Zhao

4:40PM *Long-Term Learning Behavior in a Recurrent Neural Network for Sound Recognition*
Michiel Boes, Damiano Oldoni, Bert De Coensel and Dick Botteldooren

5:00PM *Study of Learning Entropy for Novelty Detection in Lung Tumor Motion Prediction for Target Tracking Radiation Therapy*
Ivo Bukovsky, Noriyasu Homma, Matous Cejnek and Kei Ichiji

5:20PM *Opinion Retrieval through Unsupervised Topological Learning*
Nicoleta Rogovschi and Nistor Grozavu

5:40PM *A Fast Incremental Kernel Principal Component Analysis for Data Streams.*
Annie anak Joseph and Seiichi Ozawa

Special Session: ThN2-3 Neurodynamic Optimization, Chair: Sanqing Hu and Yunong Zhang, Room: 305B 228

4:00PM *A One-Layer Discrete-Time Projection Neural Network for Support Vector Classification*
Wei Zhang and Qingshan Liu

4:20PM *A Novel Discrete-Time Learning Algorithm for Speech Enhancement Using Noise Constrained Parameter Estimation*
Youshen Xia, Guiliang Lin and Weixing Zheng

4:40PM *Performance Analysis of LVI-Based PDNN Applied to Real-Time Solution of Time-Varying Quadratic Programming*
Yunong Zhang, Fangting Wu, Zhengli Xiao, Zhen Li and Binghuang Cai

5:00PM *Model Predictive Control of Multi-Robot Formation Based on the Simplified Dual Neural Network*
Xinzhe Wang, Zheng Yan and Jun Wang

5:20PM *Neurodynamics-Based Model Predictive Control of Autonomous Underwater Vehicles in Vertical Plane*
Zhiying Liu, Xinzhe Wang and Jun Wang

5:40PM *A Single Layer Recurrent Neural Network For Pseudoconvex Optimization Subject to Quasiconvex Constraints*
Jingjing Huang and Guocheng Li

6:00PM *Causality from Cz to C3/C4 or between C3 and C4 Revealed by Granger Causality and New Causality during Motor Imagery*
Sanqing Hu, Hui Wang, Jianhai Zhang, Wanzeng Kong and Yu Cao

ThN2-4 Spiking Neural Networks II, Chair: Zeng-Guang Hou, Room: 305C 230

4:00PM *Magnitude Comparison in Analog Spiking Neural Assemblies*
Jose Oliveira-Neto, Felipe Duque-Belfort, Rafael Cavalcanti-Neto and Joao Ranhel

4:20PM *Spike-Timing Dependent Morphological Learning for a Neuron with Nonlinear Active Dendrites*
Phyo Phyo San, Shaista Hussain and Arindam Basu

4:40PM *Improved Predictive Personalized Modelling with the Use of Spiking Neural Network System and a Case Study on Stroke Occurrences Data*
Muhaini Othman, Nikola Kasabov, Enmei Tu, Valery Feigin, Rita Krishnamurthi, Zeng-Guang Hou, Yixiong Chen and Jin Hu

5:00PM *Signature of an Anticipatory Response in Area V1 as Modeled by a Probabilistic Model and a Spiking Neural Network*
Bernhard A. Kaplan, Mina A. Khoei, Anders Lansner and Laurent U. Perrinet

5:20PM *Predicting Temporal Sequences Using an Event-Based Spiking Neural Network Incorporating Learnable Delays*
Tingting Gibson, James Henderson and Janet Wiles

5:40PM *Feasibility of NeuCube SNN Architecture for Detecting Motor Execution and Motor Intention for Use in BCI Applications*
Denise Taylor, Nathan Scott, Nikola Kasabov, Elisa Capecci, Enmei Tu, Nicola Saywell, Yixiong Chen, Jin Hu and Zeng-Guang Hou

11:50AM	*Continuous Variables Segmentation and Reordering for Optimal Performance on Binary Classification Tasks* Paulo Adeodato, Domingos S. P. Salazar, Lucas S. Gallindo and Abner G. Sa	
12:10PM	*Hybrid Classification with Partial Models* Bo Tang, Quan Ding, Haibo He and Steve Kay	

10:30AM	*A Decomposition Method for Large-Scale Sparse Coding in Representation Learning* Yifeng Li, Richard Caron and Alioune Ngom
10:50AM	*The Stability and Bifurcation Analysis in High Dimensional Neural Networks with Discrete and Distributed Delays* Wenying Xu, Jinde Cao and Min Xiao
11:10AM	*Restricted Boltzmann Machine Associative Memory* Koki Nagatani and Masafumi Hagiwara
11:30AM	*Two-Factor User Authentication with the CogRAM Weightless Neural Net* Weng Kin Lai, Beng Ghee Tan, Ming Siong Soo and Imran Khan
11:50AM	*The Learning of Neuro-Fuzzy Approximator with Fuzzy Rough Sets in Case of Missing Features* Robert Nowicki, Bartosz Nowak, Janusz Starczewski and Krzysztof Cpalka
12:10PM	*A Dynamic Forecasting Method for Small Scale Residential Electrical Demand* Andrei Marinescu, Ivana Dusparic, Colin Harris, Vinny Cahill and Siobhan Clarke

10:30AM	*A Spiking-Based Mechanism for Self-Organizing RBF Neural Networks* Honggui Han, Lidan Wang, Junfei Qiao and Gang Feng
10:50AM	*Support Vector Machine with SOM-Based Quasi-Linear Kernel for Nonlinear Classification* Yuling Lin, Yong Fu and Jinglu Hu
11:10AM	*The Generative Adaptive Subspace Self-Organizing Map* Thusitha Chandrapala and Bertram Shi
11:30AM	*Clustering of the Self-Organizing Map Using Particle Swarm Optimization and Validity Indices* Leonardo Enzo Brito da Silva and Jose Alfredo Ferreira Costa

1:30PM	*Model-Free Adaptive Dynamic Programming for Online Optimal Solution of the Unknown Nonlinear Zero-Sum Differential Game* Chunbin Qin, Huaguang Zhang and Yanhong Luo
1:50PM	*Direct Adaptive Control of a Four-Rotor Helicopter Using Disturbance Observer* Fuyang Chen, Bin Jiang and Feifei Lu
2:10PM	*Discrete-Time Polynomial Fuzzy Observer Designs via a Sum of Squares Approach* Yingying Wang, Huaguang Zhang, Jianyu Zhang and Yingchun Wang
2:30PM	*Adaptive Fault-Tolerant Control for a Class of Uncertain Nonlinear MISO Discrete-Time Systems in Triangular Forms with Actuator Failures* Lei Liu and Zhanshan Wang
2:50PM	*Decoupling Control for Five-Phase Fault-Tolerant Permanent-Magnet Motor by Using SVM Inverse System Method* Guohai Liu, Li Qu, Hao Zhang and Yan Jiang
3:10PM	*Fault Diagnosis of Five-Phase Fault-Tolerant Permanent-Magnet Motor Based on Principal Component Neural Network* Guohai Liu and Lu Zhou

P313 *Design of MPPT by Using Interval Type-2 T-S Fuzzy Controller*
Gwo-Ruey Yu

P314 *Robust Fuzzy Digital PID Controller Design Based on Gain and Phase Margins Specifications*
Ginalber Serra and Danubia Pires

P315 *Fuzzy Control for Kite-Based Tethered Flying Robot*
Tohru Ishii, Yasutake Takahashi, Yoichiro Maeda and Takayuki Nakamura

4:00PM *On the Creation of a Fuzzy Dataset for the Evaluation of Fuzzy Semantic Similarity Measures*
Keeley Crockett, David Chandran and David Mclean

4:20PM *A Numerical Two-Scale Model of Multi-Granularity Linguistic Variables and Its Application to Group Decision Making*
Mei Cai, Xiuzhi Sang and Xinwang Liu

4:40PM *Determining Interval Type-2 Fuzzy Set Models for Words Using Data Collected from One Subject: Person FOUs*
Jerry Mendel and Dongrui Wu

5:00PM *Twitter Topic Fuzzy Fingerprints*
Hugo Rosa, Fernando Batista and Joao Paulo Carvalho

5:20PM *On the Use of Hesitant Fuzzy Linguistic Term Set in FLINTSTONES*
Francisco J. Estrella, Rosa M. Rodriguez, Macarena Espinilla and Luis Martinez

5:40PM *Exploring Statistical Attributes Obtained from Fuzzy Agreement Models*
Simon Miller, Christian Wagner and Jonathan Garibaldi

4:00PM *A General Type-II Similarity Based Model for Breast Cancer Grading with FTIR Spectral Data*
Shabbar Naqvi, Simon Miller and Jonathan Garibaldi

4:20PM *An Interval Type-2 Fuzzy Logic Based System with User Engagement Feedback for Customized Knowledge Delivery within Intelligent E-Learning Platforms*
Khalid Almohammadi, Bo Yao and Hani Hagras

4:40PM *Fuzzy Perceptron with Pocket Algorithm in Postoperative Patient Data Set*
Suwannee Phitakwinai, Sansanee Auephanwiriyakul and Nipon Theera-Umpon

5:00PM *A Type-2 Fuzzy Logic System for Linguistic Summarization of Video Sequence in Indoor Intelligent Environments*
Bo Yao, Hani Hagras, Daniyal Alghazzawi and Mohammed J. Alhaddad

5:20PM *Designing Practical Interval Type-2 Fuzzy Logic Systems Made Simple*
Dongrui Wu and Jerry Mendel

5:40PM *Real-Time Power Aware Scheduling for Tasks with Type-2 Fuzzy Timing Constraints*
Rahul Nath, Amit K. Shukla and Pranab Muhuri

4:00PM *An Optimization Model for FML-Based Decision Support System on Energy Management*
Mei-Hui Wang, Pi-Jen Hsieh, Chang-Shing Lee, David Lupien St-Pierre and Che-Hung Liu

4:20PM *Extending FML with Evolving Capabilities through a Scripting Language Approach*
Giovanni Acampora, Marek Reformat and Autilia Vitiello

4:40PM *A Fuzzy Logic Based Reputation System for E-Markets*
Giovanni Acampora, Arcangelo Castiglione and Autilia Vitiello

2:50PM *A Crossover Operation for Evolutionary Binary Decision Diagrams*
Kai Sugimoto, Tsuyoshi Nakamura and Masayoshi Kanoh

3:10PM *Robot-Human Interaction to Encourage Voluntary Action*
Hiroyuki Masuta, Yusei Matsuo, Hun-ok Lim and Naoyuki Kubota

1:30PM *Modelling Dynamic Causal Relationship in Fuzzy Cognitive Maps*
Yuan Miao

1:50PM *Triangular Fuzzy Number Representation of Relations in Fuzzy Cognitive Maps*
Engin Yesil, Mehmet Furkan Dodurka and Leon Urbas

2:10PM *Analysis of Fuzzy Cognitive Maps with Multi-Step Learning Algorithms in Valuation of Owner-Occupied Homes*
Katarzyna Poczeta and Alexander Yastrebov

2:30PM *Learning Large-Scale Fuzzy Cognitive Maps Using a Hybrid of Memetic Algorithm and Neural Network*
Yaxiong Chi and Jing Liu

2:50PM *ICLA Imperialist Competitive Learning Algorithm for Fuzzy Cognitive Map*
Sadra Ahmadi, Somayeh Alizadeh, Nafiseh Forouzideh, Chung-Hsing Yeh, Rodney Martin and Elpiniki Papageorgiou

3:10PM *Towards a Hybrid Approach of Primitive Cognitive Network Process and Fuzzy Cognitive Map for Box Office Analysis*
Nicole Yamei Zhou and Kevin Kam Fung Yuen

1:30PM *Cooperative and Hierarchical Fuzzy MPC for Building Heating Control*
Barbara Mayer, Michaela Killian and Martin Kozek

1:50PM *A Clustering Routing Protocol for Wireless Sensor Networks Based on Type-2 Fuzzy Logic and ACO*
QiYe Zhang, ZeMing Sun and Feng Zhang

2:10PM *An Adaptive Interval Type-2 Fuzzy Logic Framework for Classification of Gait Patterns of Anterior Cruciate Ligament Reconstructed Subjects*
Owais A Malik, S. M. N. Arosha Senanayake and Danish Zaheer

2:30PM *Fuzzy Chest Pain Assessment for Unstable Angina Based on Braunwald Symptomatic and Obesity Clinical Conditions*
Thiago Orsi, Ernesto Araujo and Ricardo Simoes

2:50PM *Fuzzy Breast Cancer Risk Assessment*
Aniele C. Ribeiro, Deborha P. Silva, and Ernesto Araujo

3:10PM *Long Term Prediction for Generation Amount of Converter Gas Based on Steelmaking Production Status Estimation*
Xiaoyan Tang, Jun Zhao, Chunyang Sheng and Wei Wang

1:30PM *Fuzzy Classification of Orchard Pest Posture Based on Zernike Moments*
Wenyong Li, Shangfeng Du, Meixiang Chen, Ming Li and Chuanheng Sun

1:50PM *Fuzzy Measures of Pixel Cluster Compactness*
Gleb Beliakov, Gang Li, Quan Vu and Tim Wilkin

2:10PM *Image Composition Using F-Transform*
Marek Vajgl, Petr Hurtik, Irina Perfilieva and Petra Hodakova

3:10PM *A Preprocessed Induced Partition Matrix Based Collaborative Fuzzy Clustering for Data Analysis*
Mukesh Prasad, Dong Lin Li, Yu-Ting Liu, Linda Siana, Chin-Teng Lin and Amit Saxena

3:30PM *Dynamic Texture Classification Using Local Fuzzy Coding*
Liuyang Wang, Huaping Liu and Fuchun Sun

1:30PM *A New Monotonicity Index for Fuzzy Rule-Based Systems*
Lie Meng Pang, Kai Meng Tay and Chee Peng Lim

1:50PM *Sparse Fuzzy C-Regression Models with Application to T-S Fuzzy Systems Identification*
Minnan Luo, Fuchun Sun and Huaping Liu

2:10PM *A Systems Approach for Scheduling Aircraft Landings in JFK Airport*
Sina Khanmohammadi, Chun-An Chou, Harold W. Lewis III and Doug Elias

2:30PM *A New Fuzzy Ratio and Its Application to the Single Input Rule Modules Connected Fuzzy Inference System*
Chian Haur Jong, Kai Meng Tay and Chee Peng Lim

2:50PM *Fuzzy Uncertainty Assessment in RBF Neural Networks Using Neutrosophic Sets for Multiclass Classification*
Adrian Rubio-Solis and George Panoutsos

3:10PM *A New Adaptive Mamdani-Type Fuzzy Modeling Strategy for Industrial Gas Turbines*
Yu Zhang, Jun Chen, Chris Bingham and Mahdi Mahfouf

3:30PM *Introduction to Tunable Equivalence Fuzzy Associative Memories*
Estevao Esmi, Peter Sussner and Sandra Sandri

P701 *Reengineering Fuzzy Nested Relational Databases into Fuzzy XML Model*
Weijun Li, Xu Chen and Z. M. Ma

P702 *Evaluation of Responsiveness of Health Systems Using Fuzzy-based Technique*
Sukanya Phongsuphap and Yongyuth Pongsupap

P703 *A Fuzzy Logic Based Parkinson's Disease Risk Predictor*
Siyuan Liu, Zhiqi Shen, Martin J. McKeown, Cyril Leung and Chunyan Miao

P704 *An Integrated Intelligent Technique for Monthly Rainfall Time Series Prediction*
Jesada Kajornrit, Kok Wai Wong, Chun Che Fung and Yew Soon Ong

P705 *A Fuzzy Ontology Driven Method for a Personalized Query Reformulation*
Hajer Baazaoui-zghal and Henda Ben ghezala

P706 *A Comparison of Computational Intelligence Techniques for Energy Time Series Forecasting*
Abbas Namdar and Hamid Berenji

P707 *Perceptual Computing Based Performance Control Mechanism for Power Efficiency in Mobile Embedded Systems*
Prashant Gupta and Pranab Muhuri

P708 *Medical Diagnosis and Monotonicity Clarification Using SIRMs Connected Fuzzy Inference Model with Functional Weights*
Hirosato Seki and Tomoharu Nakashima

P709 *T-S Fuzzy Models Based Approximation for General Fractional Order Nonlinear Dynamic Systems*
Yong Wang, Yiheng Wei, Min Zhu, Mengmeng Liu, Cheng Peng and Zeshao Chen

P710 *A Mathematical Programming Method for the Multiple Attribute Decision Making with Interval Intuitionistic Fuzzy Values*
Junfeng Chu and Xinwang Liu

P711 *Fuzzy Multi Entity Bayesian Networks: A Model for Imprecise Knowledge Representation and Reasoning in High-Level Information Fusion*
Keyvan Golestan, Fakhri Karray and Mohamed S. Kamel

P712 *The Realization Problems Related to Weighted Transducers over Strong Bimonoids*
Ping Li, Yongming Li and Shengling Geng

P713 *Identification of Dynamic Systems Using a Differential Evolution-Based Recurrent Fuzzy System*
Cristian dos Santos, Rogerio Espindola, Vinicius Vieira and Alexandre Evsukoff

P714 *Similarities in Structured Spaces of Sets*
Wladyslaw Homenda and Agnieszka Jastrzebska

P715 *A Novel Low-Complexity Method for Determining Nonadditive Interaction Measures Based on Least-Norm Learning*
Wei An, Chunxiao Ren, Song Ci, Dalei Wu, Haiyan Luo and Yanwei Liu

P716 *Model Reference Adaptive Iterative Learning Control for Nonlinear Systems Using Observer Design*
Ying-Chung Wang, Chiang-Ju Chien and I-Hong Jhuo

Thursday, July 10, 4:00PM-6:00PM 300

Special Session: ThF2-1 Computational Intelligence for Cognitive Robotics, Chair: Naoyuki Kubota, Room: 201A 300

4:00PM *A Reduced Classifier Ensemble Approach to Human Gesture Classification for Robotic Chinese Handwriting*
Fei Chao, Yan Sun, Zhengshuai Wang, Gang Yao, Zuyuan Zhu, Changle Zhou, Qinggang Meng and Min Jiang

4:20PM *Reinforcement Learning in Non-Stationary Environments: An Intrinsically Motivated Stress Based Memory Retrieval Performance (SBMRP) Model*
Tiong Yew Tang, Simon Egerton and Naoyoki Kubota

4:40PM *A Modified EM Algorithm for Hand Gesture Segmentation in RGB-D Data*
Zhaojie Ju, Yuehui Wang, Wei Zeng, Haibin Cai and Honghai Liu

5:00PM *Grounding Spatial Relations in Natural Language by Fuzzy Representation for Human-Robot Interaction*
Jiacheng Tan, Zhaojie Ju and Honghai Liu

5:20PM *Vowel Recognition System of Lipsynchrobot in Lips Gesture Using Neural Network*
Indra Adji Sulistijono, Haikal Hakim Baiqunni, Zaqiatud Darojah and Didik Setyo Purnomo

5:40PM *Quantum-Inspired Multidirectional Associative Memory for Human-Robot Interaction System*
Naoki Masuyama and Chu Kiong Loo

Special Session: ThF2-2 Aggregation Operators, Chair: Simon James and Gang Li, Room: 201B 301

4:00PM *"And"- and "Or"-Operations for "Double", "Triple", etc. Fuzzy Sets*
Hung T. Nguyen, Vladik Kreinovich and Olga Kosheleva

4:20PM *Upper and Lower Generalized Factoraggregations Based on Fuzzy Equivalence Relation*
Pavels Orlovs and Svetlana Asmuss

4:40PM *Interpolative GCD Aggregators*
Jozo Dujmovic

5:00PM *Analytical Solution Methods for the Linguistic Weighted Average Problem*
Xinwang Liu, Xu Yong, Tong Wu and Na Li

5:20PM *Nearest Neighbour-Guided Induced OWA and Its Application to Journal Ranking*
Pan Su, Tianhua Chen, Changjing Shang and Qiang Shen

5:40PM *Worker Ranking Determination in Crowdsourcing Platforms Using Aggregation Functions*
David Sanchez-Charles, Jordi Nin, March Sole and Victor Muntes-Mulero

9:30AM *Multicriteria Decision Making with Fuzziness and Criteria Interdependence in Cloud Service Selection*
Le Sun, Hai Dong, Farookh Hussain, Omar Hussain, Jiangang Ma and Yanchun Zhang

9:50AM *Medical Diagnosis by Fuzzy Standard Additive Model with Wavelets*
Thanh Nguyen, Abbas Khosravi, Douglas Creighton and Saeid Nahavandi

8:10AM *Aeroengine Prognosis through Genetic Distal Learning Applied to Uncertain Engine Health Monitoring Data*
Alvaro Martinez, Luciano Sanchez and Ines Couso

8:30AM *GPFIS-Control: A Fuzzy Genetic Model for Control Tasks*
Adriano Koshiyama, Tatiana Escovedo, Marley Vellasco and Ricardo Tanscheit

8:50AM *Tuning Larger Membership Grades for Fuzzy Association Rules*
Stephen G. Matthews

9:10AM *Embedding Evolutionary Multiobjective Optimization into Fuzzy Linguistic Combination Method for Fuzzy Rule-Based Classifier Ensembles*
Krzysztof Trawinski, Oscar Cordon and Arnaud Quirin

9:30AM *Spectral-Spatial Classification of Remote Sensing Images Using a Region-Based GeneSIS Segmentation Algorithm*
Stelios Mylonas, Dimitris Stavrakoudis, John Theocharis and Paris Mastorocostas

9:50AM *Genetic-Fuzzy Mining with Type-2 Membership Functions*
Yu Li, Chun-Hao Chen, Tzung-Pei Hong and Yeong-Chyi Lee

8:10AM *Local H Infinity Control and Invariant Set Analysis for Continuous-Time T-S Fuzzy Systems with Magnitude- and Energy-Bounded Disturbances*
Dong Hwan Lee, Young Hoon Joo and Myung Hwan Tak

8:30AM *Design of Indirect Adaptive Fuzzy Control (IAFC) for Nonlinear Hysteretic Systems*
Chi-Hsu Wang, Jyun-Hong Wang and Chun-Yao Chen

8:50AM *Optimal Finite-Horizon Control with Disturbance Attenuation for Uncertain Discrete-Time T-S Fuzzy Model Based Systems*
Wen-Ren Horng, Jyh-Horng Chou and Chun-Hsiung Fang

9:10AM *Distributed Fuzzy Proportional-Spatial Integral Control Design for a Class of Nonlinear Distributed Parameter Systems*
Jun-Wei Wang, Huai-Ning Wu, Yao Yu and Chang-Yin Sun

9:30AM *Development and Implementation of Fuzzy, Fuzzy PID and LQR Controllers for an Roll-Plane Active Hydraulically Interconnected Suspension*
Sangzhi Zhu, Nong Zhang and Haiping Du

9:50AM *New Fuzzy Model with Second Order Terms for the Design of a Predictive Control Strategy*
Leonel Gutierrez, Felipe Valencia, Doris Saez and Alejandro Marquez

10:10AM *A Self-Tuning Fuzzy PID Controller Design Using Gamma Aggregation Operator*
Engin Yesil and Cagri Guzay

8:10AM *Fuzzy Community Detection in Social Networks Using a Genetic Algortihm*
Jianhai Su and Timothy Havens

8:30AM *A Minimax Model of Portfolio Optimization Using Data Mining to Predict Interval Return Rate*
Meng Yuan and Junzo Watada

8:50AM *Modeling Time Series with Fuzzy Cognitive Maps*
Homenda Wladyslaw, Jastrzebska Agnieszka and Pedrycz Witold

9:10AM *Possibilistic Projected Categorical Clustering via Cluster Cores*
Stephen G. Matthews and Trevor P. Martin

1:50PM *JuzzyOnline: An Online Toolkit for the Design, Implementation, Execution and Sharing of Type-1 and Type-2 Fuzzy Logic Systems*
Christian Wagner, Mathieu Pierfitte and Josie McCulloch

2:10PM *On Modelling Real-World Knowledge to Get Answers to Fuzzy and Flexible Searches without Human Intervention*
Victor Pablos-Ceruelo and Susana Munoz-Hernandez

2:30PM *Specialized Software for Fuzzy Natural Logic and Fuzzy Transform Applications*
Vilem Novak, Viktor Pavliska and Radek Valasek

2:50PM *A WiFi-Based Software for Indoor Localization*
Noelia Hernandez, Manuel Ocana, Sergio Humanes, Pedro Revenga, David P. Pancho and Luis Magdalena

3:10PM *Analyzing Fuzzy Association Rules with Fingrams in KEEL*
David P. Pancho, Jose M. Alonso, Jesus Alcala-Fdez and Luis Magdalena

1:30PM *Type-1 or Interval Type-2 Fuzzy Logic Systems - On the Relationship of the Amount of Uncertainty and FOU Size*
Jabran Aladi, Christian Wagner and Jonathan Garibaldi

1:50PM *Building a Type-2 Fuzzy Regression Model Based on Credibility Theory and Its Application on Arbitrage Pricing Theory*
Yicheng Wei and Junzo Watada

2:10PM *Building Linguistic Random Regression Model from the Perspective of Type-2 Fuzzy Set*
Fei Song, Shinya Imai and Junzo Watada

2:30PM *Automatic Learning of General Type-2 Fuzzy Logic Systems Using Simulated Annealing*
Majid Almaraashi, Robert John and Hopgood Adrian

2:50PM *A New Monotonic Type-Reducer for Interval Type-2 Fuzzy Sets*
Simon Coupland, Robert John and Hussam Hamrawi

3:10PM *A Support Vector-Based Interval Type-2 Fuzzy System*
Volkan Uslan, Huseyin Seker and Robert John

1:30PM *Spatiotemporal Human Brain Activities on Recalling Body Parts*
Takahiro Yamanoi, Yoshinori Tanaka, Mika Otsuki, Hisahsi Toyoshima and Toshimasa Yamazaki

1:50PM *An Interactive Evolutionary Computation Framework Controlled via EEG Signals*
Shen Ren, Jiangjun Tang, Michael Barlow and Hussein A. Abbass

2:10PM *Ocular Artifact Removal from EEG Using ANFIS*
Wei Chen, Ze Wang, Ka Fai Lao and Feng Wan

2:30PM *Description of Activity of Living Neuronal Network by Fuzzy Bio-Indicator*
Isao Hayashi and Suguru N. Kudoh

2:50PM *Human Behavioural Analysis with Self-Organizing Map for Ambient Assisted Living*
Kofi Appiah, Andrew Hunter, Ahmad Lotfi, Christopher Waltham and Patrick Dickinson

3:10PM *Analysis and Extraction of Knowledge from Body Motion Using Singular Value Decomposition*
Yinlai Jiang, Isao Hayashi and Shuoyu Wang

P114 *MOPSOhv: A New Hypervolume-Based Multi-Objective Particle Swarm Optimizer*
Ivan Chaman-Garcia, Carlos A. Coello Coello and Alfredo Arias-Montano

P115 *A Population Diversity Maintaining Strategy Based on Dynamic Environment Evolutionary Model for Dynamic Multiobjective Optimization*
Zhou Peng, Jinhua Zheng and Juan Zou

P116 *Multi-Objective Flexible Job-Shop Scheduling Problem with DIPSO: More Diversity, Greater Efficiency*
Luiz Carvalho and Marcia Fernandes

P117 *Calculating the Complete Pareto Front for a Special Class of Continuous Multi-Objective Optimization Problems*
Xiao-Bing Hu, Ming Wang and Mark S Leeson

P118 *A Self-Adaptive Evolutionary Approach to the Evolution of Aesthetic Maps for a RTS Game*
Raul Lara-Cabrera, Carlos Cotta and Antonio J. Fernandez-Leiva

P119 *Enhanced Differential Evolution with Adaptive Direction Information*
Yiqiao Cai and Jixiang Du

P120 *Visualizing the Population of Meta-Heuristics During the Optimization Process Using Self-Organizing Maps*
Marcelo Lotif

P121 *Self-Adaptive Morphable Model Based Multi-View Non-Cooperative 3D Face Reconstruction*
Kuicheng Lin, Xue Wang, Xuanping Li and Yuqi Tan

P122 *Using Electromagnetic Algorithm for Tuning the Structure and Parameters of Neural Networks*
Ayad Turky and Salwani Abdullah

P123 *Feature Selection Based on Manifold-Learning with Dynamic Constraint-Handling Differential Evolution*
Zhihui Li, Zhigang Shang, Jane Jing Liang and Boyang Qu

P124 *Metaheuristics for the 3D Bin Packing Problem in the Steel Industry*
Joaquim Viegas, Susana Vieira, Joao M. Sousa and Elsa Henriques

P125 *A New CSP Graph-Based Representation to Resource-Constrained Project Scheduling Problem*
Antonio Gonzalez-Pardo and David Camacho

P126 *Optimization Algorithm for Rectangle Packing Problem Based on Varied-Factor Genetic Algorithm and Lowest Front-Line Strategy*
Haiming Liu, Jiong Zhou, Xinsheng Wu and Peng Yuan

P127 *A Parallel Evolutionary Solution for the Inverse Kinematics of Generic Robotic Manipulators*
Siavash Farzan and Guilherme DeSouza

P128 *Feature Extraction Based on Trimmed Complex Network Representation for Metabolomic Data Classification*
Yue Chen, Zexuan Zhu and Zhen Ji

P129 *Primary Study on Feedback Controlled Differential Evolution*
Kenichi Tamura and Keiichiro Yasuda

P130 *A Route Planning Strategy for the Automatic Garment Cutter Based on Genetic Algorithm*
Wenchao Yu and Linji Lu

4:00PM *Comparative Analysis of Classical Multi-Objective Evolutionary Algorithms and Seeding Strategies for Pairwise Testing of Software Product Lines*
Roberto Erick Lopez-Herrejon, Javier Ferrer, Francisco Chicano, Alexander Egyed and Enrique Alba

4:20PM *An MOEA/D with Multiple Differential Evolution Mutation Operators*
Yang Li, Aimin Zhou and Guixu Zhang

5:00PM *A Discrete Artificial Bee Colony Algorithm for the Economic Lot Scheduling Problem with Returns*
Onder Bulut and M. Fatih Tasgetiren

5:20PM *Artificial Bee Colony for Workflow Scheduling*
Yun-Chia Liang, Hsiang-Ling Chen and Yung-Hsiang Nien

5:40PM *Cooperation Mechanism For Distributed Resource Scheduling Through Artificial Bee Colony Based Self-Organized Scheduling System*
Ana Madureira, Bruno Cunha and Ivo Pereira

6:00PM *Particle Swarm Optimization with Population Adaptation*
Nanda Dulal Jana, Swagatam Das and Jaya Sil

Tuesday, July 8, 1:30PM-3:30PM 336

Special Session: TuE1-1 Evolutionary Computation for Planning and Scheduling, Chair: Jian Xiong, Room: 203A 336

1:30PM *A Benchmark Generator for Dynamic Capacitated Arc Routing Problems*
Min Liu, Hemant Singh and Tapabrata Ray

1:50PM *A Co-Evolutionary Teaching-Learning-Based Optimization Algorithm for Stochastic RCPSP*
Huanyu Zheng, Ling Wang and Shengyao Wang

2:10PM *A Memetic Algorithm with a New Split Scheme for Solving Dynamic Capacitated Arc Routing Problems*
Min Liu, Hemant Singh and Tapabrata Ray

2:30PM *Agile Earth Observing Satellites Mission Planning Using Genetic Algorithm Based on High Quality Initial Solutions*
Zang Yuan, Yingwu Chen and Renjie He

2:50PM *Behavioral Learning of Aircraft Landing Sequencing Using a Society of Probabilistic Finite State Machines*
Jiangjun Tang and Hussein Abbass

3:10PM *Evolving Machine-Specific Dispatching Rules for a Two-Machine Job Shop using Genetic Programming*
Rachel Hunt, Mark Johnston and Mengjie Zhang

Special Session: TuE1-2 Swarm Intelligence for Real-World Engineering Optimization, Chair: Boyang Qu, Room: 203B 337

1:30PM *An Enhanced Non-Dominated Sorting Based Fruit Fly Optimization Algorithm for Solving Environmental Economic Dispatch Problem*
Xiaolong Zheng, Ling Wang and Shengyao Wang

1:50PM *Particle Swarm Optimization for Integrated Yard Truck Scheduling and Storage Allocation Problem*
Ben Niu, Ting Xie, Qiqi Duan and Lijing Tan

2:10PM *Similarity- and Reliability-Assisted Fitness Estimation for Particle Swarm Optimization of Expensive Problems*
Tong Liu, Chaoli Sun, Jianchao Zeng and Yaochu Jin

2:30PM *Binary Bacterial Foraging Optimization for Solving 0/1 Knapsack Problem*
Ben Niu and Ying Bi

2:50PM *A Discrete Artificial Bee Colony Algorithm for the Parallel Machine Scheduling Problem in DYO Painting Company*
Damla Kizilay, M. Fatih Tasgetiren, Onder Bulut and Bilgehan Bostan

3:10PM *Locality-Sensitive Hashing Based Multiobjective Memetic Algorithm for Dynamic Pickup and Delivery Problems*
Fangxiao Wang, Yuan Gao and Zexuan Zhu

P307 *Learning and Evolution of Genetic Network Programming with Knowledge Transfer*
Xianneng Li, Wen He and Kotaro Hirasawa

P308 *An Improved JADE Algorithm for Global Optimization*
Ming Yang, Zhihua Cai, Changhe Li and Jing Guan

P309 *Characterizing the Impact of Selection on the Evolution of Cooperation in Complex Networks*
Shasha Feng, Shaolin Tan and Jinhu Lu

P310 *A Tabu Search Heuristic for the Single Row Layout Problem with Shared Clearances*
Meng Yu, Xingquan Zuo and Chase C. Murray

P311 *A Weighting-Based Local Search Heuristic Algorithm for the Set Covering Problem*
Chao Gao, Thomas Weise and Jinlong Li

P312 *Parallelization for Space Trajectory Optimization*
Martin Schlueter and Masaharu Munetomo

P313 *Optimal Approximation of Stable Linear Systems with a Novel and Efficient Optimization Algorithm*
Qiaoyong Jiang, Lei Wang, Xinhong Hei, Rong Fei, Dongdong Yang, Feng Zou, Hongye Li and Zijian Cao

P314 *Extending Minimum Population Search Towards Large Scale Global Optimization*
Antonio Bolufe-Rohler and Stephen Chen

P315 *A New Penalty Function Method for Constrained Optimization Using Harmony Search Algorithm*
Biao Zhang, Jun-hua Duan, Hong-yan Sang, Jun-qing Li and Hui Yan

P316 *Scatter Search Algorithm with Chaos Based Stochasticity*
Donald Davendra, Roman Senkerik, Ivan Zelinka and Michal Pluhacek

P317 *Co-Operation of Biology Related Algorithms Meta-Heuristic in ANN-Based Classifiers Design*
Shakhnaz Akhmedova and Eugene Semenkin

P318 *Scientific Algorithms for the Car Renter Salesman Problem*
Denis Felipe, Elizabeth Goldbarg and Marco Goldbarg

P319 *A Proposal on Analysis Support System Based on Association Rule Analysis for Non-Dominated Solutions*
Shinya Watanabe, Yuta Chiba and Masahiro Kanazaki

P320 *GEAS: A GA-ES-Mixed Algorithm for Parameterized Optimization Problems - Using CLS Problem as an Example*
Xing Zhou, Wei Peng and Bo Yang

P321 *Application of Computational Intelligence for Source Code Classification*
Marcos Alvares, Fernando Buarque and Tshilidzi Marwala

P322 *Genetic Algorithm with Spatial Receding Horizon Control for the Optimization of Facility Locations*
Xiao-Bing Hu and Mark S Leeson

P323 *Tuning a Multiple Classifier System for Side Effect Discovery Using Genetic Algorithms*
Jenna Reps, Uwe Aickelin and Jonathan Garibaldi

P324 *Cooperation with Potential Leaders in Evolutionary Game Study of Networking Agents*
Jianlei Zhang, Chunyan Zhang, Tianguang Chu and Ming Cao

P325 *Multi-Objective Optimization Model Based on Steady Degree for Teaching Building Evacuation*
Pengfei Duan, Shengwu Xiong, Zhongbo Hu, Qiong Chen and Xinlu Zhong

P326 *Evolutionary Clustering Algorithm for Community Detection Using Graph-Based Information*
Gema Bello-Orgaz and David Camacho

P327 *Applying Conversion Matrix to Robots for Imitating Motion Using Genetic Algorithms*
Mari Nishiyama and Hitoshi Iba

P328 *Optimization of Combinational Logic Circuits Through Decomposition of Truth Table and Evolution of Sub-Circuits*
Francisco Manfrini, Helio Barbosa and Heder Bernadino

P329 *Reordering Dimensions for Radial Visualization of Multidimensional Data - A Genetic Algorithms Approach*
Binh Huynh Thi Thanh, Long Tran Van, Hoai Nguyen Xuan, Anh Nguyen Duc and Truong Pham Manh

P330 *An Evolutionary Approach for Combining Results of Recommender Systems Techniques Based on Collaborative Filtering*
Edjalma Queiroz Silva, Celso Goncalves Camilo-Junior, Luiz Mario Lustosa Pascoal and Thierson Couto Rosa

4:40PM *Evaluating the Performance of Group Counseling Optimizer on CEC 2014 Problems for Computational Expensive Optimization*
Subhodip Biswas, Mohammad A. Eita, Swagatam Das and Athanasios V. Vasilakos

5:00PM *Solving the IEEE-CEC 2014 Expensive Optimization Test Problems by Using Single-Particle MVMO*
Istvan Erlich, Jose L. Rueda and Sebastian Wildenhues

5:20PM *SO-MODS: Optimization for High Dimensional Computationally Expensive Multi-Modal Functions with Surrogate Search*
Tipaluck Krityakierne, Juliane Mueller and Christine Shoemaker

4:00PM *An Evolutionary Multi-Objective Approach for Prototype Generation*
Alejandro Rosales-Perez, Hugo Jair Escalante, Carlos A. Coello Coello, Jesus A. Gonzalez and Carlos A. Reyes-Garcia

4:20PM *Use EMO to Protect Sensitive Knowledge in Association Rule Mining by Removing Items*
Peng Cheng, Jeng-Shyang Pan and Chun-Wei Lin

4:40PM *An Online Evolutionary Rule Learning Algorithm with Incremental Attribute Discretization*
Essam Debie, Kamran Shafi, Kathryn Merrick and Chris Lokan

5:00PM *An External Archive Guided Multiobjective Evolutionary Approach Based on Decomposition for Continuous Optimization*
Yexing Li, Xinye Cai, Zhun Fan and Qingfu Zhang

5:20PM *Multi-Objective Differential Evolution with Leadership Enhancement (MODEL)*
Farid Bourennani, Shahryar Rahnamayan and Greg F. Naterer

5:40PM *On the Performance of Classification Algorithms for Learning Pareto-Dominance Relations*
Sunith Bandaru, Amos Ng and Kalyanmoy Deb

1:30PM *A Review of Hybrid Evolutionary Multiple Criteria Decision Making Methods*
Robin Purshouse, Kalyanmoy Deb, Maszatul M. Mansor, Sanaz Mostaghim and Rui Wang

1:50PM *MOEA/D with Tabu Search for Multiobjective Permutation Flow Shop Scheduling Problems*
Ahmad Alhindi and Qingfu Zhang

2:10PM *Online Objective Reduction for Many-Objective Optimization Problems*
Yiu-ming Cheung and Fangqing Gu

2:30PM *Diversity Preservation with Hybrid Recombination for Evolutionary Multiobjective Optimization*
Sen Bong Gee and Kay Chen Tan

2:50PM *An Evolutionary Approach to the Solution of Multi-Objective Min-Max Problems in Evidence-Based Robust Optimization*
Simone Alicino and Massimiliano Vasile

3:10PM *Kriging Model Based Many-Objective Optimization with Efficient Calculation of Expected Hypervolume Improvement*
Chang Luo, Koji Shimoyama and Shigeru Obayashi

1:30PM *Effects of Ensemble Action Selection on the Evolution of Iterated Prisoner's Dilemma Game Strategies*
Takahiko Sudo, Yusuke Nojima and Hisao Ishibuchi

1:50PM *The Structure of a Probabilistic 2-State Finite Transducer Representation for Prisoner's Dilemma*
Jeffrey Tsang

2:10PM *Competitive Coevolutionary Training of Simple Soccer Agents from Zero Knowledge*
Christiaan Scheepers and Andries Engelbrecht

2:30PM *Online Generation of Trajectories for Autonomous Vehicles Using a Multi-Agent System*
Garrison Greenwood, Saber Elsayed, Ruhul Sarker and Hussein Abbass

2:50PM *A Cooperative Coevolutionary Approach to Multi-Robot Formation Control*
Seung-Mok Lee and Hyun Myung

3:10PM *Graph Centrality Measures and the Robustness of Cooperation*
Menglin Li and Colm O'Riordan

1:30PM *Non-Invasive Detection of Hypoglycemic Episodes in Type1 Diabetes Using Intelligent Hybrid Rough Neural System*
Sai Ho Ling, Phyo Phyo San, Hak Keung Lam and Hung Nguyen

1:50PM *Image Deblurring Using a Hybrid Optimization Algorithm*
Kit Yan Chan, N. Rajakaruna, C. Rathnayake and I. Murray

2:10PM *An Algorithm for Scalable Clustering: Ensemble Rapid Centroid Estimation*
Mitchell Yuwono, Steven W. Su, Bruce D. Moulton, Ying Guo and Hung T. Nguyen

2:30PM *Evolutionary Regional Network Modeling for Efficient Engineering Optimization*
Jyh-Cheng Yu and Zhi-Fu Liang

2:50PM *Quantum Bacterial Foraging Optimization Algorithm*
Fei Li, Yuting Zhang and Haibo Li

3:10PM *A Cultural Algorithm for Spatial Forest Harvest Scheduling*
Wan-Yu Liu and Chun-Cheng Lin

1:30PM *A Hybrid Adaptive Coevolutionary Differential Evolution Algorithm for Large-Scale Optimization*
Sishi Ye, Guangming Dai and Lei Peng

1:50PM *Cooperative Co-Evolution with a New Decomposition Method for Large-Scale Optimization*
Sedigheh Mahdavi, Mohammad Ebrahim Shiri and Shahryar Rahnamayan

2:10PM *Variable Grouping Based Differential Evolution Using an Auxiliary Function for Large Scale Global Optimization*
Fei Wei, Yuping Wang and Tingting Zong

2:30PM *Solving Dynamic Double-Row Layout Problem via an Improved Simulated Annealing Algorithm*
Shengli Wang, Xingquan Zuo and Xinchao Zhao

2:50PM *Effective Decomposition of Large-Scale Separable Continuous Functions for Cooperative Co-Evolutionary Algorithms*
Mohammad Nabi Omidvar, Yi Mei and Xiaodong Li

3:10PM *Variable Neighborhood Decomposition for Large Scale Capacitated Arc Routing Problem*
Yi Mei, Xiaodong Li and Xin Yao

1:30PM *Practice in Analyzing Corporate Textual Data*
Phil Tian

1:50PM *Intel Hadoop and Its Use Cases*
Keith Qi

2:10PM *Big Data Foundation Platform for Video Analytics*
Albert Hu

2:30PM *Cloud based Air Quality Monitoring at Scale*
Fred Jiang

2:50PM *Big Data Foundation Platform for Video Analytics Demo*
Albert Hu

3:10PM *Cloud based Air Quality Monitoring at Scale Demo*
Fred Jiang

P521 *Estimation of Distribution Algorithms Based Unmanned Aerial Vehicle Path Planner Using a New Coordinate*
Peng Yang, Ke Tang and Jose Antonio Lozano

P522 *An Uncultivated Wolf Pack Algorithm for High-Dimensional Functions and Its Application in Parameters Optimization of PID Controller*
Husheng Wu, Fengming Zhang and Lushan Wu

P523 *On the Inference of Deterministic Chaos: Evolutionary Algorithm and Metabolic P System Approaches*
Luca Marchetti, Vincenzo Manca and Ivan Zelinka

P524 *A New Method and Application for Controlling the Steady-State Probability Distributions of Probabilistic Boolean Networks*
Meng Yang, Rui Li and Tianguang Chu

P525 *Evolutionary Community Detection in Social Networks*
Tiantian He and Keith C.C. Chan

P526 *Experiments in Program Synthesis with Grammatical Evolution: A Focus on Integer Sorting*
Michael O'Neill, Miguel Nicolau and Alexandros Agapitos

P527 *A Social-Evolutionary Approach to Compose a Similarity Function Used on Event Recommendation*
Luiz Mario Lustosa Pascoal, Celso Goncalves Camilo-Junior, Edjalma Queiroz Silva and Thierson Couto Rosa

P528 *Applying Evolutionary Computation for Evolving Ontologies*
Oliviu Matei, Diana Contras and Petrica Pop

4:00PM *Find Robust Solutions Over Time by Two-Layer Multi-Objective Optimization Method*
Yinan Guo, Meirong Chen, Haobo Fu and Yun Liu

4:20PM *Niching-Based Self-adaptive Ensemble DE with MMTS for Solving Dynamic Optimization Problems*
Sheldon Hui and Ponnuthurai Nagaratnam Suganthan

4:40PM *Interactive and Non-Interactive Hybrid Immigrants Schemes for Ant Algorithms in Dynamic Environments*
Michalis Mavrovouniotis and Shengxiang Yang

5:00PM *What Are Dynamic Optimization Problems?*
Haobo Fu, Peter Lewis, Bernhard Sendhoff, Ke Tang and Xin Yao

5:20PM *A Dynamic History-Driven Evolutionary Algorithm*
Chi Kin Chow and Shiu Yin Yuen

5:40PM *Adaptive Particle Swarm Optimization with Variable Relocation for Dynamic Optimization Problems*
Zhi-Hui Zhan and Jun Zhang

4:00PM *Macroscopic Indeterminacy Swarm Optimization (MISO) Algorithm for Real-Parameter Search*
Po-Chun Chang and Xiangjian He

4:20PM *A Cooperative Honey Bee Mating Algorithm and Its Application in Multi-Threshold Image Segmentation*
Yunzhi Jiang, Zhenlun Yang, Zhifeng Hao, Yinglong Wang and Huojiao He

4:40PM *A RFID Network Design Methodology for Decision Problem in Health Care*
Chun-Hua Chou, Huang Chia-Ling and Po-Chun Chang

5:00PM *Pareto Simplified Swarm Optimization for Grid-Computing Reliability and Service Makspan in Grid-RMS*
Wei Shang-Chia, Yeh Wei-Chang and Yen Tso-Jung

5:20PM *A New Grouping Genetic Algorithm for the MapReduce Placement Problem in Cloud Computing*
Xiaoyong Xu and Maolin Tang

5:40PM *Composite SaaS Scaling in Cloud Computing Using a Hybrid Genetic Algorithm*
Zeratul Mohd Yusoh and Maolin Tang

4:00PM *A Differential Evolution with Replacement Strategy for Real-Parameter Numerical Optimization*
Changjian Xu, Han Huang and ShuJin Ye

4:20PM *Evaluating the Mean-Variance Mapping Optimization on the IEEE-CEC 2014 Test Suite*
Istvan Erlich, Jose L. Rueda and Sebastian Wildenhues

4:40PM *Influence of Regions on the Memetic Algorithm for the Special Session on Real-Parameter Single Objetive Optimisation*
Daniel Molina, Benjamin Lacroix and Francisco Herrera

5:00PM *Analysis and Classification of Optimisation Benchmark Functions and Benchmark Suites*
Robert Garden and Andries Engelbrecht

5:20PM *Testing United Multi-Operator Evolutionary Algorithms on the CEC2014 Real-Parameter Numerical Optimization*
Saber Elsayed, Ruhul Sarker, Daryl Essam and Noha Hamza

5:40PM *Improving the Search Performance of SHADE Using Linear Population Size Reduction*
Ryoji Tanabe and Alex Fukunaga

4:00PM *Towards Better Generalization in Pittsburgh Learning Classifier Systems*
Shubhra Kanti Karmaker Santu, Md. Mustafizur Rahman, Md. Monirul Islam and Kazuyuki Murase

4:20PM *GP-Based Kernel Evolution for L2-Regularization Networks*
Simone Scardapane, Danilo Comminiello, Michele Scarpiniti and Aurelio Uncini

4:40PM *Generalized Classifier System: Evolving Classifiers with Cyclic Conditions*
Xianneng Li, Wen He and Kotaro Hirasawa

5:00PM *Applying LCS to Affective Images Classification in Spatial-Frequency Domain*
Po-Ming Lee and Tzu-Chien Hsiao

5:20PM *A Novel Genetic Algorithm Approach for Simultaneous Feature and Classifier Selection in Multi Classifier System*
Tien Thanh Nguyen, Alan Wee-Chung Liew, Minh Toan Tran, Xuan Cuong Pham and Mai Phuong Nguyen

5:40PM *Lookup Table Partial Reconfiguration for an Evolvable Hardware Classifier System*
Kyrre Glette and Paul Kaufmann

4:00PM *IEEE CIS Ghosts Challenge 2013*
Alessandro Sperduti

4:45PM *Evolutionary Computation for Dynamic Optimization Problems*
Changhe Li, Michalis Mavrovouniotis, Shengxiang Yang and Xin Yao

5:10PM *Optimization of Problems with Multiple Interdependent Components*
Sergey Polyakovskiy, Markus Wagner, Mohammad Reza Bonyadi, Frank Neumann and Zbigniew Michalewicz

5:35PM *First Neural Connectomics Challenge: From Imaging to Connectivity*
Demian Battaglia

P707 *A Novel Algorithm for Many-Objective Dimension Reductions: Pareto-PCA-NSGA-II*
Ronghua Shang, Kun Zhang and Licheng Jiao

P708 *An Experimental Analysis of Evolutionary Algorithms for the Three-Objective Oil Derivatives Distribution Problem*
Thatiana Souza, Elizabeth Goldbarg and Marco Goldbarg

P709 *A New Strategy for Finding Good Local Guides in MOPSO*
Man Fai Leung, Sin Chun Ng, Chi Chung Cheung and Andrew K Lui

P710 *An Inter-Molecular Adaptive Collision Scheme for Chemical Reaction Optimization*
James J.Q. Yu, Victor O.K. Li and Albert Y.S. Lam

P711 *Analysis of Constraint Handling Methods for the Gravitational Search Algorithm*
Daniel Poole, Christian Allen and Thomas Rendall

P712 *Distributed Wireless Sensor Scheduling for Multi-Target Tracking Based on Matrix-Coded Parallel Genetic Algorithm*
Zixing Cai, Sha Wen and Lijue Liu

P713 *Effect of Pseudo Gradient on Differential Evolutionary for Global Numerical Optimization*
Jinliang Ding, Lipeng Chen, Qingguang Xie, Tianyou Chai and Xiuping Zheng

P714 *Protein Folding Estimation Using Paired-Bacteria Optimizer*
Mengshi Li, Tianyao Ji, Peter Wu, Shan He and Qinghua Wu

P715 *A Self-Adaptive Group Search Optimizer with Elitist Strategy*
Xiang-wei Zheng, Dian-jie Lu and Zhen-hua Chen

P716 *Optimization Based on Adaptive Hinging Hyperplanes and Genetic Algorithm*
Jun Xu, Xiangming Xi and Shuning Wang

P717 *Combining Multipopulation Evolutionary Algorithms with Memory for Dynamic Optimization Problems*
Tao Zhu, Wenjian Luo and Lihua Yue

P718 *Micro-Differential Evolution with Vectorized Random Mutation Factor*
Hojjat Salehinejad, Shahryar Rahnamayan and Hamid R. Tizhoosh

P719 *Application of BPSO with GA in Model-Based Fault Diagnosis of Traction Substation*
Song Gao, Zhigang Liu, Chenxi Dai and Xiao Geng

P720 *Performance of AI Algorithms for Mining Meaningful Roles*
Xuanni Du and Xiaolin Chang

P721 *Using Estimation of Distribution Algorithm to Coordinate Decentralized Learning Automata for Meta-Task Scheduling*
Jie Li and Junqi Zhang

P722 *A Modular Approach for Query Spotting in Document Images and Its Optimization Using Genetic Algorithms*
Houssem Chatbri, Paul Kwan and Keisuke Kameyama

P723 *An Improved Genetic Algorithm for Dynamic Shortest Path Problems*
Xuezhi Zhu, Wenjian Luo and Tao Zhu

P724 *A Novel Genetic Algorithm Considering Measures and Phrases for Generating Melody*
Chia-Lin Wu, Chien-Hung Liu and Chuan-Kang Ting

P725 *Optimal Sizing of DGs and Storage for Microgrid with Interruptible Load Using Improved NSGA-II*
Zhe Shi, Yonggang Peng and Wei Wei

P726 *Lion Algorithm for Standard and Large Scale Bilinear System Identification: A Global Optimization Based on Lion's Social Behavior*
B. R. Rajakumar

P727 *Intelligent Search Optimized Edge Potential Function (EPF) Approach to Synthetic Aperture Radar (SAR) Scene Matching*
Yifei Wang and Jihao Yin

8:50AM *Balancing the Exploration and Exploitation in an Adaptive Diversity Guided Genetic Algorithm*
Fatemeh Vafaee, Gyorgy Turan, Peter Nelson and Tanya Berger-Wolf

9:10AM *Compensate Information from Multimodal Dynamic Landscapes: An Anti-Pathology Cooperative Coevolutionary Algorithm*
Xingguang Peng, Xiaokang Lei and Kun Liu

9:30AM *A Review of Population Initialization Techniques for Evolutionary Algorithms*
Borhan Kazimipour, Xiaodong Li and A. K. Qin

9:50AM *Running Up Those Hills: Multi-Modal Search with the Niching Migratory Multi-Swarm Optimiser*
Jonathan Fieldsend

10:30AM *Multi-Scenario Optimization Using Multi-Criterion Methods: A Case Study on Byzantine Agreement Problem*
Ling Zhu, Kalyanmoy Deb and Sandeep Kulkarni

10:50AM *Multi-Objective Evolutionary Recurrent Neural Network Ensemble for Prediction of Computational Fluid Dynamic Simulations*
Christopher Smith, John Doherty and Yaochu Jin

11:10AM *TraDE: Training Device Selection Via Multi-Objective Optimization*
Slawomir Wesolkowski, Nevena Francetic and Stuart Grant

11:30AM *Multi-view Clustering of Web Documents Using Multi-Objective Genetic Algorithm*
Wahid Abdul, Xiaoying Gao and Andreae Peter

11:50AM *Visual Examination of the Behavior of EMO Algorithms for Many-Objective Optimization with Many Decision Variables*
Hiroyuki Masuda, Yusuke Nojima and Hisao Ishibuchi

12:10PM *Sensitivity Analysis of Parallel Cell Coordinate System in Many-Objective Particle Swarm Optimization*
Wang Hu, Gary Yen and Xin Zhang

10:30AM *Real-Parameter Optimization with OptBees*
Renato Maia, Leandro de Castro and Walmir Caminhas

10:50AM *A Levy Flight-Based Hybrid Artificial Bee Colony Algorithm for Solving Numerical Optimization Problems*
Hai Shan, Toshiyuki Yasuda and Kazuhiro Ohkura

11:10AM *Comparison of Random Number Generators in Particle Swarm Opimization Algorithm*
Ke Ding and Ying Tan

11:30AM *A Evolutionary Algorithm Based on Covariance Matrix Leaning and Searching Preference for Solving CEC 2014 Benchmark Problems*
Lei Chen, Hai-Lin Liu, Zhe Zheng and Shengli Xie

11:50AM *Optimization of Power Flow with Energy Storage Using Genetic Algorithms*
Vitor Leite, Carlos Silva, Joao Claro and Joao M. Sousa

12:10PM *A New Self-Learning TLBO Algorithm for RBF Neural Modelling of Batteries in Electric Vehicles*
Zhile Yang, Kang Li, Aoife Foley and Cheng Zhang

10:30AM *Codynamic Fitness Landscapes of Coevolutionary Minimal Substrates*
Hendrik Richter

10:50AM *Model Representation and Cooperative Coevolution for Finite-State Machine Evolution*
Grant Dick and Xin Yao

11:10AM *Evolutionary Path Planning of a Data Mule in Wireless Sensor Network by Using Shortcuts*
Shao-You Wu and Jing-Sin Liu

11:30AM *Coevolutionary Genetic Algorithm for Variable Ordering in CSPs*
Muhammad Rezaul Karim and Malek Mouhoub

11:50AM *A Co-Evolutionary Multi-Objective Approach for a K-Adaptive Graph-Based Clustering Algorithm*
Hector D. Menendez, David F. Barrero and David Camacho

12:10PM *Evolving Multiplication as Emergent Behavior in Cellular Automata Using Conditionally Matching Rules*
Michal Bidlo

FrE2-4 Biometrics, Bioinformatics and Biomedical Applications, Chair: Mengjie Zhang, Room: 203D...... 385

10:30AM *Combining Graph Connectivity and Genetic Clustering to Improve Biomedical Summarization*
Hector D. Menendez, Laura Plaza and David Camacho

10:50AM *Selecting the Optimal EEG Electrode Positions for a Cognitive Task Using an Artificial Bee Colony with Adaptive Scale Factor Optimization Algorithm*
Shreyasi Datta, Pratyusha Rakshit, Amit Konar and Atulya Nagar

11:10AM *A New GP-Based Wrapper Feature Construction Approach to Classification and Biomarker Identification*
Soha Ahmed, Mengjie Zhang and Lifeng Peng

11:30AM *An Examination of Synchronisation in Artificial Gene Regulatory Networks*
Jonathan Byrne, Miguel Nicolau, Anthony Brabazon and Michael O'Neill

11:50AM *Memetic Algorithm for Sorting Unsigned Permutations by Reversals*
Jose Luis Soncco-Alvarez and Mauricio Ayala-Rincon

12:10PM *Evolved Neural Networks for HIV-1 Co-Receptor Identification*
Gary Fogel, Enoch Liu, Marco Salemi, Susanna Lamers and Michael McGrath

FrE2-5 Robotics and Engineering Applications, Chair: Amiram Moshaiov, Room: 303 386

10:30AM *Analysis of Fitness Noise in Particle Swarm Optimization: From Robotic Learning to Benchmark Functions*
Ezequiel Di Mario, Inaki Navarro and Alcherio Martinoli

10:50AM *A Comparison of Neural Networks and Physics Models as Motion Simulators for Simple Robotic Evolution*
Christiaan Pretorius, Mathys du Plessis and John Gonsalves

11:10AM *Family Bootstrapping: A Genetic Transfer Learning Approach for Onsetting the Evolution for a Set of Related Robotic Tasks*
Amiram Moshaiov and Amir Tal

11:30AM *Is MO-CMA-ES Superior to NSGA-II for the Evolution of Multi-Objective Neuro-Controllers?*
Amiram Moshaiov and Omer Abramovich

11:50AM *Optimization of the Picking Sequence of an Automated Storage and Retrieval System (AS/RS)*
Rolf Dornberger, Thomas Hanne, Remo Ryter and Stauffer Michael

12:10PM *Practical Application of an Evolutionary Algorithm for the Design and Construction of a Six-Inch Submarine*
Khairul Alam, Tapabrata Ray and Sreenatha G. Anavatti

Friday, July 11, 1:30PM-3:30PM 387

FrE3-1 Large-Scale Problems and Real-World Applications, Chair: Ke Tang, Room: 203A 387

1:30PM *A Novel Hybridization of Opposition-Based Learning and Cooperative Co-Evolutionary for Large-Scale Optimization*
Borhan Kazimipour, Mohammad Nabi Omidvar, Xiaodong Li and A. K. Qin

DETAILED PROGRAM (IJCNN 2014)

Monday, July 7, 1:30PM-3:30PM

Special Session: MoN1-1 Neuromorphic Science & Technology for Augmented Human Performance in Cybersecurity

Monday, July 7, 1:30PM-3:30PM, Room: 308, Chair: Tarek Taha and Helen Li

1:30PM *STDP Learning Rule Based on Memristor with STDP Property [#N-14227]*

Ling Chen, Chuandong Li, Tingwen Huang, Xing He, Hai Li and Yiran Chen, Chongqing University, China; Texas A and M University, Qatar; University of Pittsburgh, United States

Spike-timing-dependent plasticity (STDP) learning ability has been observed in physical memristors, but whether the STDP is caused by the neuron or the memristor is unclear. In this paper, we proved the STDP property in the model for both symmetric and asymmetric memristor. We also employed the symmetric/asymmetric memristors with STDP property and the simplified neurons to perform the STDP learning ability. At last, the sequence learning experiment of the memritive neural network (MNN) with the symmetric memristor synapse further verifies the STDP learning ability of the memristor.

1:50PM *An Adjustable Memristor Model and Its Application in Small-World Neural Networks [#N-14374]*

Xiaofang Hu, Gang Feng, Hai Li, Yiran Chen and Shukai Duan, City University of Hong Kong, China; University of Pittsburgh, United States; Southwest University, China

This paper presents a novel mathematical model for the TiO2 thin-film memristor device discovered by Hewlett- Packard (HP) labs. Our proposed model considers the boundary conditions and the nonlinear ionic drift effects by using a piecewise linear window function. Four adjustable parameters associated with the window function enable the model to capture complex dynamics of a physical HP memristor. Furthermore, we realize synaptic connections by utilizing the proposed memristor model and provide an implementation scheme for a small-world multilayer neural network. Simulation results are presented to validate the mathematical model and the performance of the neural network in nonlinear function approximation.

2:10PM *Efficacy of Memristive Crossbars for Neuromorphic Processors [#N-14690]*

Chris Yakopcic, Raqibul Hasan and Tarek Taha, University of Dayton, United States

This paper describes memristor-based neuromorphic circuits for non-linear separable pattern recognition. We initially describe a memristor based neuron circuit and then show how multilayer neural networks can be constructed using this neuron circuit. These neuromorphic circuits are capable of learning both linearly and non-linearly separable logic functions. This paper presents the first study of applying neural network learning algorithms to these circuits in SPICE. Our simulations capture alternate current paths within the memristor crossbars and wire resistances that are essential to properly model in crossbar circuits. Our results show that neural network learning algorithms are able to train around these alternate current paths. Further, it was shown that neural networks can properly train the passive memristor-based crossbars without having to use virtual ground mode operational amplifiers as suggested in previous work. Our circuit requires in-situ training, but reduces the number of transistors required by the circuit by about 3 times and reduced the circuit power consumption almost 2 orders of magnitude compared to a virtual ground approach. The key impact of this study is the demonstration through low level circuit simulations that dense memristor crossbars can be effectively utilized to build neuromorphic processors.

2:30PM *Enabling Back Propagation Training in Memristor Crossbar Neuromorphic Processors [#N-14808]*

Raqibul Hasan and Tarek Taha, University of Dayton, United States

Recent studies have shown that memristor crossbar based neuromorphic hardware enables high performance implementations of neural networks at low power and in low chip area. This paper presents circuits to train a cascaded set of memristor crossbars representing a multi-layered neural network. The circuits presented implement back-propagation training and would enable on-chip training of memristor crossbars. On-chip training of memristor crossbars can be necessary to overcome the effect of device variability and alternate current paths within crossbars being used as neural networks. We model the memristor crossbars in SPICE in order capture alternate current paths and the impact of wire resistance. Our design can be scaled to multiple neural layers and multiple output neurons. We demonstrate the training of up to three layered neural networks evaluating non-linearly separable functions through detailed SPICE simulations. This is the first study in the literature we have seen that examines the implementation of back-propagation based training of memristor crossbar circuits. The impact of this work would be to enable the design of highly energy efficient and compact neuromorphic processing systems that can be trained to implement large deep networks (such as deep belief networks).

2:50PM *Ferroelectric Tunnel Memristor-Based Neuromorphic Network with 1T1R Crossbar Architecture [#N-14910]*

Zhaohao Wang, Weisheng Zhao, Wang Kang, Youguang Zhang, Jacques-Olivier Klein and Claude Chappert, Paris-Sud University, France; Beihang University, China

Emerging ferroelectric tunnel memristors show large OFF/ON resistance ratio (>100) and high operation speed (10ns), promising to be widely applied in the future synapse-like systems. In this paper we propose a neuromorphic network with ferroelectric tunnel memristor. This network is arranged with classical crossbar topology, in which each crosspoint forms a synapse consisting of a MOS transistor and a memristor. Based on this architecture, we design a spike-timing dependent plasticity (STDP) scheme and a parallel supervised learning circuit. Using a compact model of ferroelectric tunnel memristor and CMOS 40nm design kit, we perform transient simulation to validate the functionality of the proposed STDP and learning circuit. Simulation results show the potential of our neuromorphic network in low power (100nA or 1uA) and high speed (1us or 100ns) computing system.

Special Session: MoN1-2 Artificial Neural Networks and Learning Techniques towards Intelligent Transport Systems

Monday, July 7, 1:30PM-3:30PM, Room: 305A, Chair: David Elizondo and Benjamin Passow

1:30PM *Traffic Flow Prediction Using Orthogonal Arrays and Takagi-Sugeno Neural Fuzzy Models [#N-14032]*

Kit Yan Chan and Tharam Dillon, Curtin University, Australia; Latrobe University, Australia

Takagi-Sugeno neural fuzzy models (TS-models) have commonly been applied in the development of traffic flow predictors based on traffic flow data captured by the on-road sensors installed along a freeway. However, using all captured traffic flow data is ineffective for the TS-models for traffic flow predictions. Therefore, an appropriate on-road sensor configuration consisting of significant sensors is essential to develop an accurate TS-model for traffic flow forecasting. Although the trial and error method is usually used to determine the appropriate on-road sensor configuration, it is time-consuming and ineffective in trialing all individual configurations. In this paper, a systematic and effective experimental design method involving orthogonal arrays is used to determine appropriate on-road sensor configurations for TS-models. A case study was conducted based on the development of TS-models using traffic flow data captured by on-road sensors installed on a Western Australia freeway. Results show that an appropriate on-road sensor configuration for the TS-model can be developed in a reasonable amount of time when an orthogonal array is used. Also, the developed TS-model can generate accurate traffic flow forecasting.

1:50PM *Optimal Design of Traffic Signal Controller Using Neural Networks and Fuzzy Logic Systems [#N-14179]*

Sahar Araghi, Abbas Khosravi and Creighton Douglas, Center for Intelligent Systems Research, Australia

This paper aims at optimally adjusting a set of green times for traffic lights in a single intersection with the purpose of minimizing travel delay time and traffic congestion. Neural network (NN) and fuzzy logic system (FLS) are two methods applied to develop intelligent traffic timing controller. For this purpose, an intersection is considered and simulated as an intelligent agent that learns how to set green times in each cycle based on the traffic information. The training approach and data for both these learning methods are similar. Both methods use genetic algorithm to tune their parameters during learning. Finally, The performance of the two intelligent learning methods is compared with the performance of simple fixed-time method. Simulation results indicate that both intelligent methods significantly reduce the total delay in the network compared to the fixed-time method.

2:10PM *Optimising Traffic Lights with Metaheuristics: Reduction of Car Emissions and Consumption [#N-14592]*

Jose Garcia-Nieto, Javier Ferrer and Enrique Alba, University of Malaga, Spain

In last years, enhancing the vehicular traffic flow becomes a mandatory task to minimize the impact of polluting emissions and unsustainable fuel consumption in our cities. Smart Mobility optimisation emerges then, with the goal of improving the traffic management in the city. With this aim, we propose in this paper an optimisation strategy based on swarm intelligence to find efficient cycle programs for traffic lights deployed in large urban areas. In concrete, in this work we focus on the improvement of the traffic flow with the global purpose of reducing contaminant emissions (CO2 and NOx) and fuel consumption in the analyzed areas. For the sake of standardization, we follow European Union reference framework for traffic emissions, called HandBook Emission FActors (HBEFA). As a case study, we have concentrated in two extensive urban areas in the cities of Malaga and Seville (in Spain). After several comparisons between different optimisation techniques (Differential Evolution and Random Search), as well as other solutions provided by experts, our proposal is shown to obtain significant reductions of fuel consumption and gas emissions.

2:30PM *Applying Neural-Symbolic Cognitive Agents in Intelligent Transport Systems to Reduce CO2 Emissions [#N-14658]*

Leo de Penning, Artur d'Avila Garcez, Luis Lamb, Arjan Stuiver and John-Jules Meyer, TNO, Netherlands; City University London, United Kingdom; Universidade Federal do Rio Grande do Sul, Brazil; Universiteit Utrecht, Netherlands

Providing personalized feedback in Intelligent Transport Systems is a powerful tool for instigating a change in driving behaviour and the reduction of CO2 emissions. This requires a system that is capable of detecting driver characteristics from real-time vehicle data. In this paper, we apply the architecture and theory of a Neural-Symbolic Cognitive Agent (NSCA) to effectively learn and reason about observed driving behaviour and related driver characteristics. The NSCA architecture combines neural learning and reasoning with symbolic temporal knowledge representation and is capable of encoding background knowledge, learning new hypotheses from observed data, and inferring new beliefs based on these hypotheses. Furthermore, it deals with uncertainty and errors in the data using a Bayesian inference model, and it scales well to hundreds of thousands of data samples as in the application reported in this paper. We have applied the NSCA in an Intelligent Transport System to reduce CO2 emissions as part of an European Union project, called EcoDriver. Results reported in this paper show that the NSCA outperforms the state-of-the-art in this application area, and is applicable to very large data.

2:50PM *LOGAN's Run: Lane Optimising Genetic Algorithms Based on NSGA-II [#N-14717]*

Simon R Witheridge, Benjamin Passow and Jethro Shell, De Montfort University, United Kingdom

Whilst bus lanes are an important tool to ensure bus time reliability their presence can be detrimental to urban traffic. In this paper a Non-dominated Sorting Genetic Algorithm (NSGA-II) has been adopted to study the effect of bus lanes on urban traffic in terms of location and time of operation. Due to the complex nature of this problem traditional search would not be feasible. An artificial arterial route has been modelled from real data to evaluate candidate solutions. The results confirm this methodology for the purpose of studying and identifying bus lane locations and times of operation. Additionally it is shown that bus lanes can exist on an arterial link without exclusively occupying a continuous lane for large periods of time. Furthermore results indicate a use for this methodology over a larger scale and potential near real-time operation.

Special Session: MoN1-3 Computational Intelligence for Cognitive Fault Diagnosis

Monday, July 7, 1:30PM-3:30PM, Room: 305B, Chair: Christos Panayiotou and Marios Polycarpou

1:30PM *A Cognitive Monitoring System for Contaminant Detection in Intelligent Buildings [#N-14145]*

Giacomo Boracchi, Michalis Michaelides and Manuel Roveri, Politecnico di Milano, Italy; Cyprus University of Technology, Cyprus

Intelligent buildings are equipped with sensing systems able to measure the contaminant concentration in the different building zones for safety purposes. The aim of these systems is to promptly detect the presence of a contaminant so that appropriate actions can be taken to ensure the safety of the people. At the same time, these sensing systems, which operate in real-world conditions, suffer from noise and sensor degradation faults. Both noise and faults can induce false alarms (resulting in unnecessary disruptive actions such as building evacuation) or missed alarms (when the presence of a contaminant is not detected). This paper proposes a novel cognitive monitoring system for performing contaminant detection in intelligent buildings with real-time point-trigger sensors. The proposed system reduces the occurrence of false alarms by means of a three-layered architecture, which employs cognitive mechanisms to validate possible detections and discriminate between the presence of a real contaminant source and a degradation fault affecting the sensors of the sensing system. In addition, the proposed system is able to isolate the building zone containing the contaminant source (or the faulty sensor) and estimate the onset time of the release (or the fault).

1:50PM *Learning the Deterministically Constructed Echo State Networks [#N-14533]*

Fengzhen Tang, Peter Tino and Huanhuan Chen, University of Birmingham, United Kingdom; University of Science and Technology of China, China

Echo State Networks (ESNs) have shown great promise in the applications of non- linear time series processing because of their powerful computational ability and efficient training strategy. However, the nature of randomization in the structure of the reservoir causes it be poorly understood and leaves room for further improvements for specific problems. A deterministically constructed reservoir model, Cycle Reservoir with Jumps (CRJ), shows superior generalization performance to standard ESN. However, the weights that govern the structure of the reservoir (reservoir weights) in CRJ model are obtained through exhaustive grid search which is very computational intensive. In this paper, we propose to learn the reservoir weights together with the linear readout weights using a hybrid optimization strategy. The reservoir weights are trained through non- linear optimization techniques while the linear readout weights are obtained through linear algorithms. The experimental results demonstrate that the proposed strategy of training the CRJ network tremendously improves the computational efficiency without jeopardizing the generalization performance, sometimes even with better generalization performance.

2:10PM *Inconsistent Sensor Data Detection/Correction: Application to Environmental Systems [#N-14577]*

Miquel A. Cuguero, Joseba Quevedo, Vicenc Puig and Diego Garcia, Polytechnical University of Catalonia, Spain

In this paper, a data detection/correction approach is proposed for a real environmental monitoring system, in order to provide a reliable dataset when sensor faults occur. This is the case of communication faults that may prevent the acquisition of a complete dataset, which is of paramount importance in order to successfully apply further system tasks such as fault diagnosis. Sensor detection/correction method presented here is based on the combined used of spatial and time series models. Spatial models take advantage of the physical relation between different variables emplaced in the system (temperature sensors here) while time series models take advantage of the temporal redundancy of the measured variables, by means of Holt-Winters models here. The proposed approach is successfully applied to the rock collapse forecasting system in the Torrioni di Rialba located in Lombardy (Italy).

2:30PM *Optimal Detection of New Classes of Faults by an Invasive Weed Optimization Method [#N-14801]*

Roozbeh Razavi-Far, Vasile Palade and Enrico Zio, Politecnico di Milano, Italy; University of Oxford, United Kingdom

Proper detection of unknown patterns plays an important role in diagnosing new classes of faults. This can be done by incremental learning of novel information and updating the diagnostic system by appending newly trained fault classifiers in an ensemble design. We consider a new-class fault detector previously developed by the authors and based on thresholding the normalized weighted average of the outputs (NWAO) of the base classifiers in a multi-classifier diagnostic system. A proper tuning of the thresholds in the NWAO detector is necessary to achieve a satisfactory performance. This is done in this paper by specifically introducing a performance function and optimizing it within the necessary trade-off between new class false alarm and new class missed alarm rates, by means of an Invasive Weed Optimization (IWO) algorithm. The optimal NWAO detector is tested with respect to a set of simulated sensor faults in the doubly-fed induction generator (DFIG) of a wind turbine.

2:50PM *A Distributed Virtual Sensor Scheme for Smart Buildings Based on Adaptive Approximation [#N-14954]*

Vasso Reppa, Panayiotis Papadopoulos, Marios Polycarpou and Christos Panayiotou, University of Cyprus, Cyprus

This paper presents the design of a methodology for diagnosing sensor faults in heating, ventilation and air-conditioning (HVAC) systems, and compensating their effects on the distributed control architecture. The proposed methodology is developed in a distributed framework, considering a multi-zone HVAC system as a set of interconnected, nonlinear subsystems. For each of the interconnected subsystems, we design a local virtual sensor agent that can detect and isolate faults in its monitored sensors and provide sensor fault estimations for correcting the faulty measurements. Adaptive estimation schemes are implemented in each local virtual sensor agent, using adaptive approximation models for learning the unknown fault function. Simulation results are used for illustrating the effectiveness of the proposed methodology applied to a two-zone HVAC system.

MoN1-4 Deep Learning

Monday, July 7, 1:30PM-3:30PM, Room: 305C, Chair: Donal C. Wunsch

1:30PM *From ADP to the Brain: Foundations, Roadmap, Challenges and Research Priorities [#N-14001]*

Paul Werbos, NSF, United States

This paper defines and discusses "Mouse Level Computational Intelligence" (MCLI) as a grand challenge for the coming century. It provides a four-step specific roadmap to reach that target, citing relevant work and review papers, and discusses the relation to funding priorities in two NSF funding activities - the ongoing Energy, Power and Adaptive Systems program (EPAS) and the recent initiative in Cognitive Optimization and Prediction (COPN). It elaborates on the first step, "vector intelligence," a challenge in the development of universal learning systems, which itself will require considerable new research to attain. This in turn is a crucial prerequisite to true functional understanding of how mammal brains achieve such general learning capabilities.

1:50PM *A New Active Labeling Method for Deep Learning [#N-14150]*

Dan Wang and Yi Shang, University of Missouri, United States

Deep learning has been shown to achieve outstanding performance in a number of challenging real-world applications. However, most of the existing works assume a fixed set of labeled data, which is not necessarily true in real-world applications. Getting labeled data is usually expensive and time consuming. Active labelling in deep learning aims at achieving the best learning result with a limited labeled data set, i.e., choosing the most appropriate unlabeled data to get labeled. This paper presents a new active labeling method, AL-DL, for cost- effective selection of data to be labeled. AL-DL uses one of three metrics for data selection: least confidence, margin sampling, and entropy. The method is applied to deep learning networks based on stacked restricted Boltzmann machines, as well as stacked autoencoders. In experiments on the MNIST benchmark dataset, the method outperforms random labeling consistently by a significant margin.

2:10PM *Parallel Tempering with Equi-Energy Moves for Training of Restricted Boltzmann Machines [#N-14417]*

Nannan Ji and Jiangshe Zhang, Xi'an Jiaotong University, China

Training RBMs is laborious due to the difficulty of sampling from model's distribution. Although using Parallel Tempering (PT) alleviates the problem to some extent, it will result in low swap acceptance ratio when the states' energies of neighboring chains are very different. In this paper, we propose a novel PT algorithm based on the principle of swapping between chains with the same level of energy. This new algorithm partitions the state space obtained by a population of Gibbs sampling chains into several energy rings. In each ring, states have similar energies and swapping of each pair of states are conducted with a probability. Experiments on a toy dataset as well as the MNIST dataset shown that the new algorithm keeps high swap acceptance ration and results in better likelihood scores compared to several training methods.

2:30PM *EOG-Based Drowsiness Detection Using Convolutional Neural Networks [#N-14429]*

Xuemin Zhu, Wei-Long Zheng, Bao-Liang Lu, Xiaoping Chen, Shanguang Chen and Chunhui Wang, Shanghai Jiao Tong University, China; China Astronaut Research and Training Center, China

This study provides a new application of convolutional neural networks for drowsiness detection based on electrooculography (EOG) signals. Drowsiness is charged to be one of the major causes of traffic accidents. Such application is helpful to reduce losses of casualty and property. Most attempts at drowsiness detection based on EOG involve a feature extraction step, which is accounted as time-consuming task, and it is difficult to extract effective features. In this paper, an unsupervised learning is proposed to estimate driver fatigue based on EOG. A convolutional neural network with a linear regression layer is applied to EOG signals in order to avoid using of manual features. With a postprocessing step of linear dynamic system (LDS), we are able to capture the physiological status shifting. The performance of the proposed model is evaluated by the correlation coefficients between the final outputs and the local error rates of the subjects. Compared with the results of a manual ad-hoc feature extraction approach, our method is proven to be effective for drowsiness detection.

2:50PM *Using Recurrent Networks for Non-Temporal Classification Tasks [#N-14557]*

Saurav Biswas, Muhammad Zeshan Afzal and Thomas Breuel, Technical University Kaiserslautern, Germany

In recent years, deep neural networks have led to considerable advances in the performance of neural network architectures. However, deep architectures tend to have a large numbers of parameters, leading to long training times and the need for huge amounts of training data and regularization. In addition, biological neural networks make extensive use of recurrent and feedback connections, which are absent for most commonly used deep architectures. In this paper, we investigate the use of recurrent neural networks as an alternative to deep architectures. The approach replaces depth with recurrent computations through time. It can also be seen as a deep architecture with parameter tying. We show that for a comparable numbers of parameters or complexity, replacing depth with recurrency can result in improved performance.

3:10PM *Computation of Deep Belief Networks Using Special-Purpose Hardware Architecture [#N-14825]*

Byungik Ahn, Korea Telecom, Korea, Republic of

The computation of deep belief networks (DBNs) requires a large number of arithmetic operations, which can be handled only by arithmetic operators. However, the operators are utilized only a small fraction of the time (1-5%) when they are computed by general-purpose computers. In this paper, a special- purpose hardware architecture that computes DBNs using a large number of arithmetic operators with a utilization rate greater than 60% is proposed. On the basis of neuron machine architecture, the computation units in the system are controlled according to stage operation table, which specify the sequence of the computation stages; thus, the complicated procedure of the DBN can be carried out in hardware. Moreover, the usage of the memory space is considerably improved by using offset addressing. The proposed schemes are implemented on a hardware simulator coded in MATLAB and on an FPGA chip. The full source code of the hardware simulator is available at a website. The readers can execute the code on the fly and reproduce the proposed schemes. The FPGA implementation achieves a lower computational time by a factor greater than 100 compared to a PC.

MoN1-5 Ensemble and Meta Learning

Monday, July 7, 1:30PM-3:30PM, Room: 305D, Chair: Robi Polikar

1:30PM *Neural Networks and AdaBoost Algorithm Based Ensemble Models for Enhanced Forecasting of Nonlinear Time Series [#N-14013]*

Yilin Dong, Jianhua Zhang and Jonathan Garibaldi, East China University of Science and Technology, China; University of Nottingham, United Kingdom

In this paper an optimized AdaBoost Regression and Threshold (AdaBoost.RT) algorithm based on feed-forward neural networks is evaluated. The AdaBoost.RT algorithm is used to combine an ensemble of feed-forward neural networks trained by using backpropagation algorithm (FFN-BP). The ensemble model is validated by using two typical time-series data, namely Chua's circuit and CATS benchmark data. The performance of the ensemble models is shown to outperform several existing approaches.

1:50PM *An Improved Boosting Scheme Based Ensemble of Fuzzy Neural Networks for Nonlinear Time Series Prediction [#N-14114]*

Yilin Dong and Jianhua Zhang, East China University of Science and Technology, China

This paper proposed a Modified AdaBoost.RT (AdaBoost Regression and Threshold) algorithm based on Fuzzy Neural Networks (FNNs) and its application to the accurate prediction of complex nonlinear time-series. The algorithm is validated by using four typical time-series data, namely Lorenz, Mackey-Glass, Sunspot and Dow Jones Indices data. The performance comparison of the proposed method and several existing approaches is also performed to show its advantages for nonlinear time series prediction problems.

2:10PM *On Optimal Wavelet Bases for Classification of Skin Lesion Images through Ensemble Learning [#N-14490]*

Grzegorz Surowka and Maciej Ogorzalek, Jagiellonian University, Poland

In order to recognize early symptoms of melanoma, the fatal cancer of the skin, systems for computer aided melanoma diagnosis have been developed for years. In this work we analyze an ensemble-based binary classifier for discriminating melanoma from dysplastic nevus utilizing wavelet-based features of the dermatoscopic skin lesion images. The multiresolution decomposition of the dermatoscopy images is done through wavelet packets. We search for the optimal wavelet base maximizing the quality of the classifier in terms of AUC for models optimized by some common quality measures: accuracy, precision, F1-score, FP rate, specificity, BER and recall. Within the statistics of our experiments reverse bi-orthogonal wavelet rbio3.1 makes the best wavelet model of melanoma.

2:30PM *From Low Negative Correlation Learning to High Negative Correlation Learning [#N-14522]*

Liu Yong, University of Aizu, Japan

Besides the studied transition learning between the two different ensemble learning algorithms such as negative correlation learning and balanced ensemble learning, transition learning could also implemented in negative correlation learning with different correlation penalties. On one hand, negative correlation learning with the lower correlation penalty named as low negative correlation learning might learn too much the training data while generating less negatively correlated neural networks. On the other hand, negative correlation learning with the higher correlation penalty called as high negative correlation learning might not be able to learn the training data, but be capable of generating highly negatively correlated neural networks. By conducting transition learning from low negative correlation learning to high negative correlation learning, this paper shows that the ensembles could have both the good performance and the diverse individual neural networks.

2:50PM *An Algorithmic Framework Based on the Binarization Approach for Supervised and Semi-Supervised Multiclass Problems [#N-14668]*

Ayon Sen, Md. Monirul Islam and Kazuyuki Murase, Bangladesh University of Engineering and Technology, Bangladesh; University of Fukui, Japan

Using a set of binary classifiers to solve the multiclass classification problem has been a popular approach over the years. This technique is known as binarization. The decision boundary that these binary classifiers (also called base classifiers) have to learn is much simpler than the decision boundary of a multiclass classifier. But binarization gives rise to a new problem called the class imbalance problem. Class imbalance problem occurs when the data set used for training has relatively less data items for one class than for another class. This problem becomes more severe if the original data set itself was imbalanced. Furthermore, binarization has only been implemented in the domain of supervised classification. In this paper, we propose a framework called Binarization with Boosting and Oversampling (BBO). Our framework can handle the class imbalance problem arising from binarization. As the name of the framework suggests, this is achieved through a combination of boosting and oversampling. BBO framework can be used with any supervised classification algorithm. Moreover, unlike any other binarization approaches used earlier, we apply our framework with semi-supervised classification as well. BBO framework has been rigorously tested with a number of benchmark data sets from UCI machine learning repository. The experimental results show that using the BBO framework achieves a higher accuracy than the traditional binarization approach.

3:10PM *A Hierarchical Learning Approach to Calibrate Allele Frequencies for Snp Based Genotyping of Dna Pools [#N-14512]*

Andrew Hellicar, Daniel Smith, Ashfaqur Rahman, Ulrich Engelke and John Henshall, Commonwealth Scientific and Industrial Research Organisation, Australia

The combination of low density SNP arrays and DNA pooling is a fast and cost effective approach to genotyping that opens up basic genomics to a range of new applications and studies. However we have identified significant limitations in the existing approach to calculating allele frequencies with DNA pooling. These limitations include a reduced ability to deal with SNP to SNP variation via the standard interpolation method. Our contribution is a new hierarchical learning framework which resolves these drawbacks. The framework involves a hierarchy of two greedily trained layers of learners. The first layer learns the bias of each SNP then applies a calibration to reduce SNP bias by mapping into a common coordinate system across all SNPs. The second layer learns an allele frequency function exploiting the global SNP data. A range of algorithms have been applied including linear regression, neural network and support vector regression. The framework has been tested on pooled samples of Black Tiger prawns that have been genotyped with low density Sequenom iPLEX panels. Analysis of pooled samples and the corresponding individually genotyped SNP samples indicate the pooling approach introduces an allele frequency RMS error of 0.12. The existing calibration approach corrects 14% of the error. Our hierarchical approach is 4.5 times as effective by correcting for 64% of the introduced error. This is a significant reduction and has the potential to enable genetic studies previously not possible due to allele frequency error. Although testing so far is limited to low density SNP arrays the approach was developed to generalize to other SNP genotyping technologies.

MoN1-6 Time Series Analysis I

Monday, July 7, 1:30PM-3:30PM, Room: 305E, Chair: Andrea Burattin

1:30PM *Multi-Objective Cooperative Coevolution of Neural Networks for Time Series Prediction [#N-14129]*

Shelvin Chand and Rohitash Chandra, University of South Pacific, Fiji

The use of neural networks for time series prediction has been an important focus of recent research. Multi-objective optimization techniques have been used for training neural networks for time series prediction. Cooperative coevolution is an evolutionary computation method that decomposes the problem into subcomponents and has shown promising results for training neural networks. This paper presents a multi-objective cooperative coevolutionary method for training neural networks where the training data set is processed to obtain the different objectives for multi-objective evolutionary training of the neural network. We use different time lags as multi-objective criterion. The trained multi-objective neural network can give prediction of the original time series for preprocessed data sets distinguished by their time lags. The proposed method is able to outperform the conventional cooperative coevolutionary methods for training neural networks and also other methods from the literature on benchmark problems.

1:50PM *Multivariate Time Series Prediction Based on Multiple Kernel Extreme Learning Machine [#N-14187]*

Xinying Wang and Min Han, Dalian University of Technology, China

In this paper, a multiple kernel extreme learning machine (MKELM) is proposed for multivariate time series prediction. The multivariate time series is reconstructed in phase space, and a variable selection algorithm is then applied to form the compact and relevant input for the prediction model. On the basis of multiple kernel learning and extreme learning machine with kernels, multi different kernels is used in MKELM to present the dynamics of multivariate time series. A simulation example, prediction of Lorenz chaotic time series is conducted to demonstrate the effectiveness of the proposed method.

2:10PM *Cooperative Coevolution of Feed Forward Neural Networks for Financial Time Series Problem [#N-14322]*

Shelvin Chand and Rohitash Chandra, University of South Pacific, Fiji

Intelligent financial prediction systems guide investors in making good investments. Investors are continuously on the hunt for better financial prediction systems. Neural networks have shown good results in the area of financial prediction. Cooperative coevolution is an evolutionary computation method that decomposes the problem into subcomponents and has shown promising results for training neural networks. This paper presents a computational intelligence framework for financial prediction where cooperative coevolutionary feedforward neural networks are used for predicting closing market prices for companies listed on the NASDAQ stock exchange. Problem decomposition is an important step in cooperative coevolution that affects its performance. Synapse and Neuron level are the main problem decomposition methods in cooperative coevolution. These two methods are used for training neural networks on the given financial prediction problem. The results show that Neuron level problem decomposition gives better performance in general. A prototype of a mobile application is also given for investors that can be used on their Android devices.

2:30PM *Forecasting Time Series - A Layered Ensemble Architecture [#N-14494]*

Md. Mustafizur Rahman, Shubhra Kanti Karmaker Santu, Md. Monirul Islam and Kazuyuki Murase, Bangladesh University of Engineering and Technology, Bangladesh; Univeristy of Fukui, Japan

Time series forecasting (TSF) have been widely used in many application areas such as science, engineering and finance. The characteristics of phenomenon generating a series are usually unknown and information available for forecasting is only limited to the past values of the series. It is, therefore, necessary to use an appropriate number of past values, termed lag, for forecasting. This paper presents a layered ensemble architecture (LEA) for TSF problems. Our architecture is consisted of two layers, each of which uses an ensemble of neural networks. Unlike most previous studies on TSF, LEA puts emphasis on both accuracy and diversity among individual networks in an ensemble. While the ensemble of the first layer tries to find an appropriate lag of a given time series, it of the second layer makes forecasting using the obtained lag. The use of the appropriate lag signifies LEA's effort in producing accurate networks for constructing the ensemble. In order to maintain diversity among networks in the ensemble, LEA trains each network in the ensemble using a different training set. The proposed architecture uses a clustering based selection method that considers both accuracy and diversity in selecting networks to construct the ensemble. Accuracy is maintained here by selecting the best networks from each cluster. On the other hand, diversity is ensured by using the variance information in constructing clusters. LEA has been tested extensively on the time series data sets of NN3 competition. In terms of prediction accuracy, our experimental results have showed clearly that LEA is better than other ensemble and non-ensemble algorithms.

2:50PM *Sets with Incomplete and Missing Data - NN Radar Signal Classification [#N-14752]*

Ivan Jordanov and Nedyalko Petrov, University of Portsmouth, United Kingdom

We investigate further the problem of radar signal classification and source identification with neural networks. The available large dataset includes pulse train characteristics such as signal frequencies, type of modulation, pulse repetition intervals, scanning type, scan period, etc., represented as a mixture of continuous, discrete and categorical data. Typically, considerable part of the data samples are with missing values. In our previous work we used only part of the radar dataset, applying listwise deletion to get rid of the samples with missing values and processing relatively small subset of complete data. In this work we apply multiple imputation (MI) method, which is a model based approach of dealing with missing data, by producing confidence intervals for unbiased estimates without loss of statistical power (using both complete and incomplete cases). We applied MI to all data samples with up to 60% missingness, this way increasing more than twice the size of the initially used data subset. We apply feedforward backpropagation neural network (NN) supervised learning for solving the classification and identification problem. We investigate the same three case studies as from the previous paper and report improved, superior results for all of them, which is a consequence of the implemented MI and improved NN training.

3:10PM *Application of Artificial Neural Network and Multiple Linear Regression Models for Predicting Survival Time of Patients with Non-Small Cell Cancer Using Multiple Prognostic Factors Including FDG-PET Measurements [#N-14795]*

Yonglin Pu, Michael Baad, Yisheng Chen and Yulei Jiang, the University of Chicago, United States; Novast Laboratories, Ltd, China

We hypothesize and demonstrate that artificial neural networks (ANN) can perform better than multiple linear regression models in overcoming the limitations of the current TNM staging system for predicting the overall survival time of patients with non-small cell lung cancer (NSCLC). Better prognostication of survival was achieved by including additional prognostic factors, such as FDG- PET measurements and other clinical and pathological prognostic factors. The use of an ANN resulted in a substantial improvement in correlation between actual and predicted months of survival in 328 patients with NSCLC. The ANN resulted in an increase in R^2, from 0.66 to 0.774, and a reduction in standard deviation, from 17.4 months to 14 months, when compared to multiple linear regressions. Furthermore, the cross-validation results of R^2 = 0.608 suggests that the ANN model was capable of predicting survival for patients who were not included in the database for building the ANN model.

MoN1-7 Approximate Dynamic Programming and Reinforcement Learning

Monday, July 7, 1:30PM-3:30PM, Room: 303, Chair: Qinglai Wei

1:30PM *Near-Optimal Online Control of Uncertain Nonlinear Continuous-Time Systems Based on Concurrent Learning [#N-14155]*

Xiong Yang, Derong Liu and Qinglai Wei, Chinese Academy of Sciences, China

This paper develops a novel observer-critic architecture for solving the near-optimal control problem of uncertain nonlinear continuous-time systems. Two neural networks (NNs) are employed in the architecture: an observer NN is constructed to get the knowledge of uncertain system dynamics and a critic NN is utilized to derive the optimal control. The weights of the observer NN and the critic NN are tuned simultaneously. By using the recorded and instantaneous data concurrently, the critic NN can not only derive the optimal control without persistence of excitation but also ensure the closed-loop system to be uniformly ultimately bounded. No initial stabilizing control is required in the developed algorithm. An illustrated example is provided to demonstrate the effectiveness of the presented approach.

1:50PM *Finite Horizon Stochastic Optimal Control of Nonlinear Two-Player Zero-Sum Games under Communication Constraint [#N-14390]*

Hao Xu and Jagannathan Sarangapani, Missouri University of Science and Technology, United States

In this paper, the finite horizon stochastic optimal control of nonlinear two-player zero-sum games, referred to as Nonlinear Networked Control Systems (NNCS) two-player zero-sum game, between control and disturbance input players in the presence of unknown system dynamics and a communication network with delays and packet losses is addressed by using neuro dynamic programming (NDP). The overall objective being to find the optimal control input while maximizing the disturbance attenuation. First, a novel online neural network (NN) identifier is introduced to estimate the unknown control and disturbance coefficient matrices which are needed in the generation of optimal control input. Then, the critic and two actor NNs have been introduced to learn the time-varying solution to the Hamilton-Jacobi-Isaacs (HJI) equation and determine the stochastic optimal control and disturbance policies in a forward-in-time manner. Eventually, with the proposed novel NN weight update laws, Lyapunov theory is utilized to demonstrate that all closed-loop signals and NN weights are uniformly ultimately bounded (UUB) during the finite horizon with ultimate bounds being a function of initial conditions and final time. Further, the approximated control input and disturbance signals tend close to the saddle-point equilibrium within finite-time. Simulation results are included.

2:10PM *Neural-Network-Based Optimal Control for a Class of Complex-Valued Nonlinear Systems with Input Saturation [#N-14735]*

Ruizhuo Song and Qinglai Wei, University of Science and Technology Beijing, China; Chinese Academy of Sciences, China

This paper proposes an optimal control scheme based on adaptive dynamic programming (ADP) algorithm for complex-valued systems with input saturation. The equivalence transformation is used to obtain the real dynamic system, and then the performance index function is defined. Based on the transformed system, an ADP optimal control method is established. The update methods for critic network neural network and action network are given. It is proved that the closed-loop system is uniformly ultimately bounded based on Lyapunov approach. Finally, the simulation study was given to show the effectiveness of the proposed optimal control scheme.

2:30PM *Policy Iteration Approximate Dynamic Programming Using Volterra Series Based Actor [#N-14775]*

Wentao Guo, Jennie Si, Feng Liu and Shengwei Mei, Tsinghua University, China; Arizona State University, United States

There is an extensive literature on value function approximation for approximate dynamic programming (ADP). Multilayer perceptrons (MLPs) and radial basis functions (RBFs), among others, are typical approximators for value functions in ADP. Similar approaches have been taken for policy approximation. In this paper, we propose a new Volterra series based structure for actor approximation in ADP. The Volterra approximator is linear in parameters with global optima attainable. Given the proposed approximator structures, we further develop a policy iteration framework under which a gradient descent training algorithm for obtaining the optimal Volterra kernels can be obtained. Associated with this ADP design, we provide a sufficient condition based on actor approximation error to guarantee convergence of the value function iterations. A finite bound of the final convergent value function is also given. Finally, by using a simulation example we illustrate the effectiveness of the proposed Volterra actor for optimal control of a nonlinear system.

2:50PM *Online Adaptation of Controller Parameters Based on Approximate Dynamic Programming [#N-14779]*

Wentao Guo, Feng Liu, Jennie Si and Shengwei Mei, Tsinghua University, China; Arizona State University, United States

Controller parameter tuning is an integral part of control engineering practice. Existing tuning methods usually start with an accurate mathematical model of the controlled system, which may pose some challenges for practicing engineers dealing with real systems. As such, parameter optimization and adaptation are treated as two independent steps during tuning. To address these issues, we propose a new, online parameterized controller tuning method for a general nonlinear dynamic system. This tuning method is based on direct heuristic dynamic programming (direct HDP), a model-free algorithm in the approximated dynamic programming (ADP) family. By using a Lyapunov stability approach, we provide uniformly ultimately bounded (UUB) results under some mild conditions for controller parameters, the critic neural network weights, and the action neural network weights. Simulation studies based on the benchmark cart-pole system demonstrate adaptability and optimization capabilities of the proposed controller parameter tuning method.

3:10PM *LASOM: Location Aware Self-Organizing Map for Discovering Similar and Unique Visual Features of Geographical Locations [#N-14945]*

Dmitry Kit, Yu Kong and Yun Fu, Northeastern University, United States

Can a machine tell us if an image was taken in Beijing or New York? Automated identification of the geographical coordinates based on image content is of particular importance to data mining systems, because geolocation provides a large source of context for other useful features of an image. However, successful localization of unannotated images requires a large collection of images that cover all possible locations. Brute-force searches over the entire databases are costly in terms of computation and storage requirements, and achieve limited results. Knowing what visual features make a particular location unique or similar to other locations can be used for choosing a better match between spatially distance locations. However, doing this at global scales is a challenging problem. In this paper we propose an on-line, unsupervised, clustering algorithm called Location

Aware Self-Organizing Map (LASOM), for learning the similarity graph between different regions. The goal of LASOM is to select key features in specific locations so as to increase the accuracy in geotagging untagged images, while also reducing computational and storage requirements. Different from other Self-Organizing Map algorithms, LASOM provides the means to learn a conditional distribution of visual features, conditioned on geospatial coordinates. We demonstrate that the generated map not only preserves important visual information, but provides additional context in the form of visual similarity relationships between different geographical areas. We show how this information can be used to improve geotagging results when using large databases.

3:30PM *Algorithmic Trading Behavior Identification Using Reward Learning Method [#N-14790]*

Steve Yang, Qifeng Qiao, Peter Beling and Scherer William, Stevens Institute of Technology, United States; University of Virginia, United States

Identifying and understanding the impact of algorithmic trading on financial markets has become a critical issue for market operators and regulators. Advanced data feed and audit trail information from market operators now make the full observation of market participants' actions possible. A key question is the extent to which it is possible to understand and characterize the behavior of individual participants from observations of trading actions. In this paper, we consider the basic problems of categorizing and recognizing traders (or, equivalently, trading algorithms) on the basis observed limit orders. Our approach, which is based on inverse reinforcement learning (IRL), is to model trading decisions as a Markov decision process and then use observations of an optimal decision policy to find the reward function. The approach strikes a balance between two desirable features in that it captures key empirical properties of order book dynamics and yet remains computationally tractable. Making use of a real-world data set from the E-Mini futures contract, we compare two principal IRL variants, linear IRL and Gaussian process IRL. Results suggest that IRL-based feature spaces support accurate classification and meaningful clustering.

Monday, July 7, 3:30PM-6:00PM

Poster Session: PN1 Poster Session 1

Monday, July 7, 3:30PM-6:00PM, Room: Posters Area (Level 3), Chair: Marios Polycarpou

P101 *Hidden Space Discriminant Neighborhood Embedding [#N-14017]*

Chuntao Ding, Li Zhang and Bangjun Wang, Soochow University, China

Discriminant neighborhood embedding (DNE) algorithm is one of supervised linear dimensionality reduction methods. Its nonlinear version kernel discriminant neighborhood embedding (KDNE) is expected to behave well on classification tasks. However, since KDNE constructs an adjacent graph in the original space, the adjacency graph could not represent the adjacent information in the kernel mapping space. By introducing hidden space, this paper proposes a novel nonlinear method for DNE, called hidden space discriminant neighborhood embedding (HSDNE). This algorithm first maps the data in the original space into a high dimensional hidden space by a set of nonlinear hidden functions, and then builds an adjacent graph incorporating neighborhood information of the dataset in the hidden space. Finally, DNE is used to find a transformation matrix which would map the data in the hidden space to a low-dimensional subspace. The proposed method is applied to ORL face and MNIST handwritten digit databases. Experimental results show that the proposed method is efficiency for classification tasks.

P102 *A Supervised Neighborhood Preserving Embedding for Face Recognition [#N-14022]*

Xing Bao, Li Zhang, Bangjun Wang and Jiwen Yang, Soochow University, China

Neighborhood preserving embedding (NPE) is an approximation to locally linear embedding (LLE), which has an ability to preserve local neighborhood structure on data manifold. As an unsupervised dimensionality reduction method, NPE can be applied to face recognition for preprocessing. However, NPE could not utilize the label information in the classification tasks. To make the data in a reduced subspace separable, this paper proposes a supervised neighborhood preserving embedding which could learn a projection matrix by using both the geometrical manifold structure and the label information of the given data. In addition, the projection matrix could be found by solving a linear set of equations. Experimental results on ORL and Yale face image datasets show that the proposed method has a high recognition rate.

P103 *Asymmetric Mixture Model with Variational Bayesian Learning [#N-14025]*

Thanh Nguyen and Wu Jonathan, University of Windsor, Canada

Bayesian detection for the symmetric Gaussian mixture model has recently received great attention for pattern recognition problems. However, in many applications, the distribution of the data has a non-Gaussian and non-symmetric form. This study presents a new asymmetric mixture model for model detection. In this paper, the proposed asymmetric distribution is modeled with multiple Student's-t distributions, which are heavily tailed and more robust than Gaussian distributions. Our method has the flexibility to fit different shapes of observed data such as non-Gaussian and non-symmetric. Another advantage is that the proposed algorithm, which is based on the variational Bayesian learning, can simultaneously optimize over the number of the Student's-t distribution that is used to model each asymmetric distribution, and the number of components. The performance of the proposed model is compared to other mixture models, demonstrating the robustness, accuracy, and effectiveness of our method.

P104 *A New Weight Initialization Method for Sigmoidal Feedforward Artificial Neural Networks [#N-14030]*

Sartaj Singh Sodhi, Pravin Chandra and Sharad Tanwar, Guru Gobind Singh Indraprastha University, India; Deloitte Consulting India Private Ltd., India

Initial weight choice has been recognized to be an important aspect of the training methodology for sigmoidal feedforward neural networks. In this paper, a new mechanism for weight initialization is proposed. The mechanism distributes the initial input to output weights in a manner that all weights (including thresholds) leading into a hidden layer are uniformly distributed in a region and the center of the region from which the weights are sampled are such that no region overlaps for two distinct hidden nodes. The proposed method is compared against random weight initialization routines on five function approximation tasks using the Resilient Backpropagation (RPROP) algorithm for training. The proposed method is shown to lead to about twice as fast convergence to a pre-specified goal for training as compared to any of the random weight initialization methods. Moreover, it is shown that at least for these problems the networks reach a deeper minima of the error

functional during training and generalizes better than the networks trained whose weights were initialized by random weight initialization methods.

P105 *Fast Orthogonal Linear Discriminant Analysis with Applications to Image Classification [#N-14051]*

Qiaolin Ye, Ning Ye, Haofeng Zhang and Chunxia Zhao, Nanjing Forestry University, China; Nanjing University of Science and Technology, China

Orthogonalized variant of Linear Discriminant Analysis (LDA) is an effective statistical learning tool for dimension reduction. However, existing orthogonalized LDA algorithms suffer from various drawbacks, including the requirement for expensive computing time. This paper develops an efficient algorithm for dimension reduction, referred to as Fast Orthogonal Linear Discriminant Analysis (FOLDA), which adopts an iterative procedure to extract the orthogonal projection vectors. Different from previous efforts, this new approach applies QR decomposition and regression to solve for a new projection vector in each time of iterations, leading to the by far cheaper computational cost. FOLDA can achieve comparable recognition rates to existing orthogonal LDA algorithms. Experimental results on image databases, such as MNIST, COIL20, MEPG-7, and OUTEX, show the effectiveness and efficiency of FOLDA.

P106 *Stability Analysis of Nonlinear Time-Delay System with Delayed Impulsive Effects [#N-14060]*

Guizhen Feng and Jinde Cao, Southeast University, China

This paper concerns time-delay systems with delayed impulses. "Average impulsive intervals" is used to replace the lower and upper bounds of impulsive intervals, which weakens the limitations to the impulsive sequences. Under some modified conditions on the impulsive functions and the Lyapunov-based function, the exponential stability of systems is established. A specific impulsive delayed system with linear input time-delays is investigated by virtue of the obtained results. Finally, some numerical example is given to demonstrate the applicability of our results.

P107 *Learning Discriminative Low-Rank Representation for Image Classification [#N-14068]*

Jun Li, Heyou Chang and Jian Yang, Nanjing University of Science and Technology, China

Low-rank representation (LRR) efficiently performs the subspace segmentation and feature extraction from corrupted data. However, there have three disadvantages in existing LRR techniques. First, the inference algorithm of LRR (as a generative model) is computationally expensive. Second, LRR ignores the discriminative information for image classification. Third, although the robust representation is implemented by recovering the low-rank components and the sparse noises, it has been limited due to the constrained assumption that noises is sparse. To solve these problems, and inspired by Denoising Autoencoders (DAE) and Contractive Autoencoders (CAE), this paper proposes a discriminative low-rank representations framework (DLRR) for image classification. We directly learn a discriminative projection dictionary that results in fast inference. Simultaneously, DLRR can obtain a robust representation from any corrupted input. Our implementation of DLRR achieves state-of-the-art results on artificial dataset and dataset of Olivetti Face Patches.

P108 *Supervised Bayesian Sparse Coding for Classification [#N-14069]*

Jinhua Xu, Li Ding and Shiliang Sun, East China Normal University, China

In this paper, we propose a supervised Bayesian sparse coding (SBSC) model for classification. The sparse coding with Laplacian scale mixture prior is formulated as a weighted l_1 minimization problem. Category-specific discriminative dictionaries and regularization parameters are learned using variational EM algorithm from the training samples of each category. Instability of previous sparse coding methods is alleviated through the regularizer design. Classification of a test sample is done using the MAP estimate of the sparse codes. We have tested the model on different recognition tasks and demonstrated the effectiveness of the model.

P109 *Writer-Independent Handwritten Signature Verification Based on One-Class SVM Classifier [#N-14094]*

Yasmine Guerbai, Youcef Chibani and Bilal Hadjadji, USTHB, Algeria

The limited number of writers and the lack of forgeries as counterexample to construct the systems is the main difficulty task for designing a robust off- line Handwritten Signature Verification System (HSVS). In this paper, we propose to study the influence of writer's number using conjointly the curvelet transform and the One-Class Support Vector Machine (OC-SVM), which takes in consideration only genuine signatures. The design of the HSVS is based on the writer-independent approach. Experimental results conducted on the standard CEDAR and GPDS datasets demonstrate that the proposed method allows achieving the lowest Average Error Rate with a limited number of writers.

P110 *Attack Detection in Recommender Systems Based on Target Item Analysis [#N-14097]*

Wei Zhou, Junhao Wen, Yun Sing Koh, Shafiq Alam and Gillian Dobbie, Chongqing University, China; the University of Auckland, New Zealand

Recommender systems are highly vulnerable to attacks. Attackers who introduce biased ratings in order to affect recommendations, have been shown to be effective against collaborative filtering algorithms. In this paper, we study the use of statistical metrics to detect rating patterns of attackers. Two metrics, Rating Deviation from Mean Agreement (RDMA) and Degree of Similarity with Top Neighbors (DegSim), are used for analysing rating patterns between malicious profiles and genuine profiles in shilling attacks. Building upon this, we propose and evaluate an algorithm for detecting shilling attacks in recommender systems using a statistical approach. We look at two attack models: random attack and average attack. The experimental results show that our detection technique based on target item analysis is an effective approach in detecting shilling attacks for both the random and average attack model.

P111 *Video Attention Saliency Mapping Using Pulse Coupled Neural Network and Optical Flow [#N-14104]*

Qiling Ni and Xiaodong Gu, Fudan University, China

This paper proposes a biologically inspired video attention saliency detector by combining optical flow and topological properties. In this paper, we expound how to utilize feature informations of video and how to use topological property and optical flow based on attention detection for target tracking. Visual attention used in our model is a consequence of tuning of some saliency features such as color, shape and motion. The model (OFTPA-Optical Flow Topological Properties Attention) we proposed for motion attention saliency detection includes two stages. First stage focuses on extracting saliency features, including optical-flow velocity field, topological properties and Intensity, from video. The second integrates the traditional saliency features and an extra position prediction calculated from optical-flow field, to form bottom-up saliency maps which indicate where the object candidates are located. Spatiotemporal saliency maps are obtained from the phase spectrum of a video's hypercomplex Fourier transform. Experimental results show that the OFTPA model takes advantage over other models such as PQFT in complex background.

P112 *Optimized Selection of Training Samples for One-Class Neural Network Classifier [#N-14111]*

Hadjadji Bilal and Chibani Youcef, USTHB, Algeria

One-Class Classification (OCC) based on the Auto-Associative Neural Networks (AANN) has been widely used in various recognition applications for its effective robustness. Its main advantage lies in the description of samples more accurately to other OCCs. However, it is considerably sensitive to the presence of outliers or noisy data contained into the training set, which may affect badly the representative model. Hence, we propose in

this paper an algorithm that uses the AANN for selecting the most representative training samples. The same AANN is retrained to reproduce the selected samples for generating an optimal representative model. The experimental evaluation conducted on several real-world benchmarks confirms the effective use of the Selected Training Samples for Associative Neural Network (STS-AANN) versus the training on the entire set.

P113 *Zernike Moments Descriptor Matching Based Symmetric Optical Flow for Motion Estimation and Image Registration [#N-14125]*

Qiuying Yang and Ying Wen, East China Normal University, China

The conventional optical flow has a fundamental limitation in handling motion details and image registration. In this paper, we propose a Zernike moments descriptor matching based symmetric optical flow estimation for high-quality image registration and motion estimation, which is an integration strategy of descriptor matching of Zernike moments and symmetric optical flow estimation. Zernike moment has less information redundancy and low sensitivity to noise compared to other moments and can well describes the shape characteristics of the objects. Thus, the descriptors obtained by Zernike moments that are defined on the driving points in an image can well reflect the underlying structure. During the computation of descriptors, we hierarchically select the driving points that have distinct attribute features, thus, drastically reducing ambiguity in finding correspondence. Furthermore, a simple and efficient inverse consistency optical flow is proposed with aims of motion estimation and higher registration accuracy, where the flow is naturally symmetric. Experiments implemented on Middlebury beach dataset, MIT dataset and magnetic resonance brain images demonstrate the effectiveness of the proposed method.

P114 *A Pairwise Algorithm for Training Multilayer Perceptrons with the Normalized Risk-Averting Error Criterion [#N-14127]*

Yichuan Gui, James Lo and Yun Peng, University of Maryland, United States

Proper use of the normalized risk-averting error (NRAE) criterion has been shown to avoid nonglobal local minima effectively in the mean squared error (MSE) criterion. For training on large datasets, a pairwise algorithm for the NRAE criterion similar to the widely-used least mean square algorithm for the MSE criterion is proposed. The gradual deconvexification method employing this pairwise algorithm is tested on examples with built-in nonglobal local minima that are difficult to avoid and on recognition of handwritten numerals with the MNIST dataset. Numerical experiments show that the pairwise algorithm for the NRAE criterion is computationally more economical than the corresponding batch algorithm and delivers multilayer perceptrons with better performances than training methods based on the MSE criterion.

P115 *A Model with Fuzzy Granulation and Deep Belief Networks for Exchange Rate Forecasting [#N-14140]*

Ren Zhang, Furao Shen and Jinxi Zhao, State Key Laboratory for Novel Software Technology at Nanjing University, China

In recent years, neural networks is increasingly adopted in the prediction of exchange rate. However, most of them predict a specific number, which can not help the speculators too much because small gap between the predicted values and the actual values will lead to disastrous consequences. In our study, our purpose is to present a model to forecast the fluctuation range of the exchange rate by combining Fuzzy Granulation with Continuous-valued Deep Belief Networks (CDBN), and the concept of "Stop Loss" is introduced for making the environment of our profit strategy close to the real foreign exchange trade market. The proposed model is applied to forecasting both Euro/US dollar and British pound/US dollar exchange rate in our experiments. Experimental results show that the proposed method is more profitable in the trading process than other typical models.

P116 *Control of Methylamine Removal Reactor Using Neural Network Based Model Predictive Control [#N-14156]*

Zhi Long Liu, Feng Yang, Ke Jun Zhou and Mei Xu, University of Electronic Science and Technology of China, China; Chongqing University of Post and Telecommunications, China

Methylamine (MA) removal process using mixed bacteria strains depends highly on constant temperature (303 K), at which the mixed bacteria strains provide highest activity in removing MA. Controlling MA removal reactor is extremely difficult for its inherent process nonlinearities and complex reaction kinetics and other uncertain factors. In the designed approach, a network predicted model is trained as a nonlinear process to predict the future output of the controlled process according to current and previous input and output over the specified horizon. The advanced predictive control strategy is used to minimize the cost function in order to calculate the optimal output of the controller. In this work, a neural network based predictive control (NNMPC) algorithm was implemented to control the temperature of MA removal reactor and the controller performance in set-point tracking and disturbance rejection was investigated, and the performance results of NNMPC was compared with conventional PID controller. It is concluded that the NNMPC performance is superior to the conventional PID controller in the control of MA removal reactor.

P117 *A Genetic Algorithm Based Double Layer Neural Network for Solving Quadratic Bilevel Programming Problem [#N-14193]*

Jingru Li, Junzo Watada, Yunlong Guo and Shamshul Bahar Yaakob, Waseda University, Japan

In this paper, an intelligent genetic algorithm (IGA) and a double layer neural network (NN) are integrated into a hybrid intelligent algorithm for solving the quadratic bilevel programming problem. The intelligent genetic algorithm is used to select a set of potential solution combinations from the entire generated combinations of the upper level. Then a meta-controlled Boltzmann machine, which is formulated by comprising the Hopfield model (HM) and the Boltzmann machine (BM), is used to effectively and efficiently determine the optimal solution of the lower level. Numerical experiments on examples show that the genetic algorithm based double layer neural network enables us to efficiently and effectively solve quadratic bilevel programming problems.

P118 *Detection of Filter-Like Cellular Automata Spectra [#N-14211]*

Eurico Ruivo and Pedro de Oliveira, Mackenzie Presbyterian University, Brazil

The Fourier spectra of one-dimensional cellular automata give a quantitative and qualitative characterisation of the average final configurations obtained out of their rules, as they are applied to sets of random initial configurations. The elementary cellular automata rule space presents spectra that bring to mind those of digital filters, and the same happens to some of the cellular automata rules obtained through composition of particular elementary cellular automata. As such, one might be willing to discover other filter type rules that might exist in larger spaces. In order to explore the possibility of detecting these cellular automata in a larger space, two methods are applied: a Multilayer Perceptron and the k-Nearest Neighbours classification algorithm. Both algorithms presented considerably high accuracies, with the Multilayer Perceptron showing an overall lower false negative rate, thus indicating that the methods may be generalised to other rule spaces and to the detection of other features, providing an automatic method to detect features in cellular automata spectra.

P119 *A Brain-Like Multi-Hierarchical Modular Neural Network with Applications to Gas Concentration Forecasting [#N-14220]*

Zhaozhao Zhang and Junfei Qiao, LiaoNing Technical University, China; Beijing University of Technology, China

This paper presents a novel modular neural network called brain-like multi-hierarchical modular network (BMNN). Unlike most of the traditional modular neural network, the BMNN has a brain-like multi-hierarchical structure and uses a collaborative learning approach. In BMNN learning process, each input sample is learned by multiple sub-sub-modules in different sub-modules and the learning result of BMNN is the integration of the multiple sub-sub-modules learning results, which helps to improve the BMNN's learning accuracy and generalization ability. The learning algorithm of the sub-sub-modules is an algebraic method which greatly improves the BMNN's learning speed. Applied BMNN to mine gas concentration forecasting based on the practical production data, the forecasting results compared with BP neural network and RBF neural network, the experiment results show the validity of the proposed forecasting method and can provide the scientific decision for the safety in coal mine production.

P120 *Fast Ship Detection of Synthetic Aperture Radar Images via Multi-View Features and Clustering [#N-14224]*

Shigang Wang, Shuyuan Yang, Zhixi Feng and Licheng Jiao, Xidian University, China

This paper proposes a novel ship detection scheme in coastal regions for high- resolution synthetic aperture radar (SAR) imagery based on prior knowledge of the different properties presented by target and clutter. To begin with, image segmentation and land masking are applied to eliminate the areas that are unlikely to contain targets and get the index image which indicates the likely target positions. Ship detection is conducted only on these likely target positions using power ring algorithm (PR), which can avoid unnecessary and exhaustive searches. In the discrimination stage, two new features named number of 8 connected regions and average power of target areas are proposed and used to form a discriminative feature group. Unlike most discriminators, which are based on supervised learning, we use an unsupervised method based on K-means clustering to deal with the situations where there are few or no labeled samples. Experimental results show that the proposed scheme is fast in speed and can detect most of the targets while few false alarms occur.

P121 *Deep Learning to Classify Difference Image for Image Change Detection [#N-14235]*

Jiaojiao Zhao, Maoguo Gong, Jia Liu and Licheng Jiao, Xidian University, China

Image change detection a process to analyze multi-temproal images of the same scene for identifying the changes that have occurred. In this paper, we propose a novel difference image analysis approach based on deep neural networks for image change detection problems. The deep neural network learning algorithm for classification includes unsupervised feature learning and supervised fine-tuning. Some samples with the labels of high accuracy obtained by a pre-classification are used for fine-tuning. Since a deep neural network can learn complicated functions that can represent high-level abstractions, it can obtain satisfactory results. Theoretical analysis and experiment results on real datasets show that the proposed method outperforms some other methods.

P122 *Performance of Combined Artificial Neural Networks for Forecasting Landslide Displacement [#N-14213]*

Lian Cheng, Zhigang Zeng, Yao Wei and Huiming Tang, Huazhong University of Science and Technology, China; South-Central University for Nationalities, China; China University of Geosciences, China

An efficient and accurate method for landslide displacement prediction is very important to reduce the casualties and property losses caused by this type of natural hazard. In recent years, many kinds of artificial neural networks (ANNs) have been widely applied to landslide displacement prediction. But we can't know which type of ANN is the best until we have calculated the prediction error. An improper choice of ANN may result in bad prediction results. In this paper, we use a neural networks combination prediction method based on the discounted MSFE (mean squared forecast error) to reduce the risk of selecting the types of ANNs. Four popular ANNs, radial basis function neural network (RBFNN), support vector regression (SVR), least squares support vector machine (LSSVM) and extreme learning machine (ELM), are selected as candidate neural networks. The performance of our model is verified through two case studies in Baishuihe landslide and Bazimen landslide. Experimental results reveal that the combining neural networks can improve the generalization abilities of ANNs.

P123 *Butterfly Communication Strategies: A Prospect for Soft-Computing Techniques [#N-14222]*

Sowmya Ch, Anjumara Shaik, Chakravarthi Jada and Anil Kumar Vadathya, Rajiv Gandhi University of Knowledge Technologies, India

This paper aims to show a new source of inspiration through Butterfly Communication Strategies to the field of Soft Computing. Inspirations and the algorithms that have been proposed already in this field have been surveyed and efforts have been put to provide the understanding of principal communication strategies of butterfly mating along with the different traits playing major role in it. The principal mating mechanisms were virtually shown with various experimental results using compatible software. The proposals were initiated from the observations to bring a collective movement or localization which could be one of the main aims in the field of soft computing.

P124 *A New Transfer Learning Boosting Approach Based on Distribution Measure with an Application on Facial Expression Recognition [#N-14225]*

Shihai Wang and Zeling Li, Beihang University, China

In the machine learning community, most algorithms proposed, particularly for inductive learning, are based entirely on one crucial assumption: that the training and test data points are drawn or generated from the exact same distribution. If this condition is not fully satisfied, most learning algorithms or models are corrupted. In this paper, we propose a new instance based transductive transfer learning method based on Boosting framework by using a distribution measure approach. There follows a detailed description of this distribution measure approach. Subsequently, we describe our boosting transfer learning method in detail and report its performance in facial expression recognition tasks.

P125 *Adaptive Output Feedback Control for Cooperative Dynamic Positioning of Multiple Offshore Vessels [#N-14232]*

Lu Liu, Dan Wang and Zhouhua Peng, Dalian Maritime University, China

This paper considers cooperative dynamic positioning (CDP) of multiple offshore vessels in the presence of dynamical uncertainties, time-varying ocean disturbances and unmeasured velocity, aimed at collectively holding a relative formation and reaching a reference position. K-filter observers are first designed to estimate the unmeasured velocity information of each vessel, and then observer based CDP controllers are developed with the aid of

dynamic surface control (DSC) technique, neural network and iterative learning approach. The formation among vehicles can be guaranteed if the graph induced by the vessels and the reference point contains a spanning tree. It is proved by Lyapunov analysis that the proposed control laws can ensure that all the signals in the closed-loop systems are uniformly ultimately bounded, and tracking errors converge to a small neighborhood of origin.

P126 *Hierarchical Organization in Neuronal Functional Networks during Working Memory Tasks [#N-14239]*

Hu Lu, Zhe Liu, Yuqing Song and Hui Wei, Fudan University, China; Jiangsu university, China

Existing studies have shown that neuronal functional networks (NFNs) exhibit small-world properties. However, the issue of whether NFNs have any other complex network topology properties remains unresolved. In this paper, we introduced a new hierarchical clustering-based method that can clearly indicate the hierarchical modular organization of NFNs. Based on the modularity function Q proposed by Newman, we can divide the NFNs into suitable sub-modules. We proposed a new measure function to calculate the correlations between pairs of spike trains without requiring binning of the spike trains through small time windows. This method can be used to analyze the level of synchronization between spike trains and functional connectivity relationships between neurons. We analyzed NFNs constructed from multi-electrode recordings in rat brain cerebral cortexes in vivo. These rats had been trained to perform different working memory cognitive tasks. The results show that NFNs exhibit a clear hierarchical modular organization in rat brains. These results provided evidence confirming that the brain networks are complex. This can also be used as a means of studying the relationship between neuronal functional organization and cognitive behavioral tasks.

P127 *Shrunk Support Vector Clustering [#N-14248]*

Ping Ling, Xiangsheng Rong, Guosheng Hao and Yongquan Dong, Jiangsu Normal University, China; Air Force Logistics of P. L. A, China

Compared with Support Vector Machine (SVM) that has shown success in classification tasks, Support Vector Clustering (SVC) is not widely viewed as a competitor to popular clustering algorithms. The reason is easy to state that classical SVC is of high cost and moderate performance. In spite of ever-appearing variants of SVC, they fail in solving two problems well. Focusing on these two problems, this paper proposes a Shrunk Support Vector Clustering (SSVC) algorithm that makes an effort to address two difficulties simultaneously. In the optimization piece SSVC pursues a shrunk hypersphere in feature space that only dense-region data are included in. In the labeling piece of SSVC, a new labeling approach is designed to cluster support vectors firstly, and then label other data. The development of the shrunk hypersphere is implemented by optimizing a strongly convex objective, which can be converted to a linear equation system. A fast training method is given to reduce the heavy computation burden that is necessary in SVC to solve a quadratic optimization problem. The new labeling approach is based on geometric nature of the shrunk model and works in a simple but informed way. That removes the randomness encoded in SVC labeling piece and then improves clustering accuracy. Experiments indicate SSVC's better performance and efficiency than its peers and much appealing facility compared with the state of the art.

P128 *Oil Spill GF-1 Remote Sensing Image Segmentation Using an Evolutionary Feedforward Neural Network [#N-14250]*

Jianchao Fan, Dongzhi Zhao and Jun Wang, National Ocean Environment Monitoring Center, China; The Chinese University of Hong Kong, China

To improve self-made satellites in the marine oil spill monitoring accuracy, it is presented that a Gao Fen (GF-1) satellite marine oil spill remote sensing (RS) image classification algorithm based on a novel evolutionary neural network. First, a non-negative matrix factorization (NMF) algorithm is employed to extract the image features. Compared with basic features, such as the image spectrum and texture, structuring more targeted oil spill image localization nonnegative character fits better for the physical significance of remote sensing images. Furthermore, on the basis of the new features, a new feedforward neural network structure with particle swarm optimization (PSO) algorithm is proposed for GF-1 RS image segmentation. Simulation results of the oil spill event substantiate the effectiveness of the proposed approach to GF-1 satellite image segmentation.

P129 *Deep Process Neural Network for Temporal Deep Learning [#N-14272]*

Wenhao Huang and Haikun Hong, Peking University, China

Process neural network is widely used in modeling temporal process inputs in neural networks. Traditional process neural network is usually limited in structure of single hidden layer due to the unfavorable training strategies of neural network with multiple hidden layers and complex temporal weights in process neural network. Deep learning has emerged as an effective pre-training method for neural network with multiple hidden layers. Though deep learning is usually limited in static inputs, it provided us a good solution for training neural network with multiple hidden layers. In this paper, we extended process neural network to deep process neural network. Two basic structures of deep process neural network are discussed. One is the accumulation first deep process neural network and the other is accumulation last deep process neural network. We could build any architecture of deep process neural network based on those two structures. Temporal process inputs are represented as sequences in this work for the purpose of unsupervised feature learning with less prior knowledge. Based on this, we proposed learning algorithms for two basic structures inspired by the numerical learning approach for process neural network and the auto-encoder in deep learning. Finally, extensive experiments demonstrated that deep process neural network is effective in tasks with temporal process inputs. Accuracy of deep process neural network is higher than traditional process neural network while time complexity is near in the task of traffic flow prediction in highway system.

P130 *Dynamic Boosting in Deep Learning Using Reconstruction Error [#N-14273]*

Wenhao Huang and Haikun Hong, Peking University, China

Deep learning has attracted a lot of attention in research and industry in recent years. In this paper, we proposed a dynamic boosting strategy according to reconstruction error in deep networks. We use reconstruction error to determine whether the result is reliable or not. From the perspective of prediction interval, we demonstrated that with the increase of reconstruction error, the prediction interval would become bigger. Therefore, the classification result is not reliable when the reconstruction error exceeds the pre- determined threshold. Since we can record the reconstruction error as well as the classification error for all training samples in training set. We can learn an extra boosting model besides the deep network in training set to improve the performance of the model. An important factor in learning the boosting model is to determine an appropriate threshold for selecting training samples. In testing, we first examine whether the reconstruction error of a testing sample exceeds the threshold to determine if we should use the boosting model. If the boosting model is used, the final result is the average of the output of the deep network and the boosting model. We conducted experiments on two widely used classification datasets and an air quality dataset. From the experiments, we see that our boosting strategy is effective in improving the performance of classification. We tested several boosting models in this paper. They can all reduce the test error to some extent under appropriate parameter settings.

P131 *Efficient Diminished-1 Modulo 2n+1 Multiplier Architectures [#N-14283]*

Xiaolan Lv and Ruohe Yao, Guangdong University of Petrochemical Technology, China; South China University of Technology, China

The efficient architectures for diminished-1 modulo 2^n+1 multipliers are described. The results and operands of the new modulo 2^n+1 multipliers

use the diminished-1, avoiding n+1 bit circuit. And the presented multipliers can handle zero inputs and results. The proposed modulo 2^n+1 multiplier are built using three major functional modules, partial products generation block, partial products reduction block and a final diminished-1 adder block. The final modulo 2^n+1 addition block is built around a sparse carry computation unit for the analytical and experimental results. And this indicates that the significant area and power of the proposed multipliers is superior to the earlier proposals, with a high operation speed.

P132 *A Classifier-Based Association Test for Imbalanced Data Derived from Prediction Theory [#N-14295]*

Johannes Mohr, Sambu Seo and Klaus Obermayer, Technische Universitaet Berlin, Germany

How can we test for group differences in multidimensional input patterns, such as functional magnetic resonance imaging measurements or gene expression values? One solution is to split the available data into training and test set, and to estimate the generalization accuracy of a classifier that predicts the group variable from the input pattern. If this lies significantly above chance level, we can reject the null hypothesis of no association. This test is straightforward for balanced data, where all groups are equally frequent in the data set. However, data sets collected in observational studies are often imbalanced. Then accuracy is no longer a suitable measure of performance, and balanced accuracy should be used instead. In this paper, we give an overview on existing analytical tests and use the framework of prediction theory to derive a new test for the balanced accuracy of a classifier. We then use numerical simulations to evaluate the type I error rate and the power of two tests for imbalanced data.

P133 *Issues on Sampling Negative Examples for Predicting Prokaryotic Promoters [#N-14305]*

Eduardo Gusmao and Marcilio de Souto, Rheinisch-Westfaelische Technische Hochschule Aachen University, Germany; University of Orleans, France

Supervised learning methods have been successfully used to build classifiers for the identification of promoter regions. The classifier is often built from a dataset that has examples of promoter (positive) and non-promoter (negative) regions. Thus, a careful selection of the data used for constructing and evaluating a promoter finding algorithm is a very important issue. In this context, experimentally known promoter regions can be safely assumed to be positive training instances. In contrast, since definite knowledge whether a given region represents a non-promoter is not generally available, negative instances are not straightforward to be obtained. To make the problem more complex, for the case of promoter, there is not a unique definition of what a negative instance is. As a consequence, depending on which definition of non- promoter region one assumed to build the data, such a choice could affect significantly the performance of the classifier and/or yield a biased estimate of the performance. We present an empirical study of the effect of this kind of problem for promoter prediction in E. coli. As far as we are concerned, up to now, there is no such a kind of study for the context of prokaryotic promoter prediction.

P134 *Singular Spectrum Analysis of P300 for Classification [#N-14307]*

Shirin Enshaeifar, Saeid Sanei and Clive Cheong Took, University of Surrey, United Kingdom

In this work, we introduce a complex-valued singular spectrum analysis for the analysis of electroencephalogram (EEG), which typically exhibits noncircular probability distribution. To exploit such prior knowledge, our technique makes use of recent advances in complex-valued statistics to exploit the power difference or the correlation between the data channels, in contrast to current methods which cater only for the restrictive class of circular data. In particular, the principal component analysis-like technique was employed to detect the onset of P300, and tracked this event-related potential. In this way, the classification of EEG can be made possible to differentiate between a healthy subject and a schizophrenic patient. We illuminate how features such as P3a and P3b can be used to perform such classification.

P135 *Vessel Segmentation in Retinal Images with a Multiple Kernel Learning Based Method [#N-14325]*

Xiaoming Liu, Zhigang Zeng and Xiaoping Wang, Huazhong University of Science and Technology, China

Blood vessel segmentation is an important problem for quantitative structure analysis of retinal images, and many diseases are related to the structure changes. Manual segmentation is time consuming and computer aided segmentation is required to deal with large amount images. This paper presents a new supervised method for segmentation of blood vessels in retinal photographs. Multiple kernel learning (MKL) is introduced to deal with the problem, utilizing features from Hessian matrix based vesselness measure, response of multiscale Gabor filter, and multiple scale line strength features. The method is evaluated on the publicly available DRIVE and STARE databases. The performance of the MKL method is evaluated and experimental results show the high accuracy of the proposed method.

P136 *Content-Based Image Retrieval by Dictionary of Local Feature Descriptors [#N-14704]*

Patryk Najgebauer, Tomasz Nowak, Jakub Romanowski, Marcin Gabryel, Marcin Korytkowski and Rafal Scherer, Czestochowa University of Technology, Poland

This paper describes a concept of image keypoint descriptors indexing and comparison method used to speed up the process of image comparison and retrieval. As the main advantage of the dictionary-based representation is faster comparison between sets of image descriptors we assumed that the proposed approach will be more effcient than the standard list representation. The presented method sorts and groups components of descriptors in the process of dictionary creation. The ordered structure of the image descriptor dictionary is well suited for quick comparison of images by comparing their dictionaries of descriptors or by comparing individual descriptors with the dictionary. This allows to skip a large part of operations during descriptors comparison between two images. The proposed method also compares descriptors including the threshold of deviations tolerance between descriptors. Thanks to this, the method can also match descriptors which values are different but they are similar enough that they should be considered as the same. The tolerance threshold has been introduced to the method because the descriptors of identical keypoints in different images almost always have dissimilar values, it is caused by the method of descriptors generation, as well as keypoints rotation and scale. The structure of images has also an impact because the vertical and horizontal lines are better rendered by diagonal lines. Another advantage is grouping of similar descriptors in the process of dictionary creation, it is based on combining components of descriptors. By this approach, the amount of total descriptors for comparison is reduced.

P137 *The Performance of a Recurrent Honn for Temperature Time Series Prediction [#N-14659]*

Rozaida Ghazali, Noor Aida Husaini, Lokman Hakim Ismail and Yana Mazwin Hassim, Universiti Tun Hussein Onn Malaysia, Malaysia

This paper presents a novel application of Recurrent HONN to forecast the future index of temperature time series data. The prediction capability of Recurrent HONN, namely the Recurrent Pi-Sigma Neural Network was tested on a five-year temperature data taken from Batu Pahat, Malaysia. The performance of the network is benchmarked against the performance of Multilayer Perceptron, and the standard Pi-Sigma Neural Network. The predictions demonstrated that Recurrent Pi-Sigma Neural Network is capable in predicting the future index of temperature series in comparison to other models. It is observed that the network is able to find an appropriate input output mapping of the chaotic temperature signals with a good performance in learning speed and generalization capability.

P138 *EEG-Based Emotion Recognition Using Discriminative Graph Regularized Extreme Learning Machine [#N-14392]*

Jia-Yi Zhu, Wei-Long Zheng, Ruo-Nan Duan, Yong Peng and Bao-Liang Lu, Shanghai Jiao Tong University, China

This study aims at finding the relationship between EEG signals and human emotional states. Movie clips are used as stimuli to evoke positive, neutral and negative emotions of subjects. We introduce a new effective classifier named discriminative graph regularized extreme learning machine (GELM) for EEG-based emotion recognition. The average classification accuracy of GELM using differential entropy (DE) features on the whole five frequency bands is 80.25 percent, while the accuracy of SVM is 76.62 percent. These results indicate that GELM is more suitable for emotion recognition than SVM. Additionally, the accuracies of GELM using DE features on Beta and Gamma bands are 79.07 percent, 79.93 percent respectively. This suggests that these two bands are more relevant to emotion. The experimental results indicate that the EEG patterns for emotion are generally stable among different experiments and subjects. By using minimal-redundancy-maximal-relevance (MRMR) algorithm and correlation coefficients to select effective features, we get the distribution of top 20 subject-independent features and build a manifold model to monitor the trajectory of emotion changes with time.

P139 *Posture Classification of Lying Down Human Bodies Based on Pressure Sensors Array [#N-14800]*

William Cruz Santos, Alberto Beltran Herrera, Eduardo Vazquez Santacruz and Mariano Gamboa Zuniga, UAEM-Zumpango, Mexico; CGSTIC, CINVESTAV-IPN, Mexico

Human posture classification is an important tasks in medical applications, i.e., patient monitoring, ulcer prevention, and conduct diagnostic. We propose an Intelligence System for posture classification of lying- down human bodies using a low-resolution pressure sensor array. A support vector- machine was used to perform the classification of pressure maps. Four databases were constructed in order to represent the pressure maps: pressure raw-data, interpolated raw-data, HOG and SIFT image descriptor vectors. It was found that the image descriptors have improved complexity time to build the classification models rather than using raw- and interpolated pressure maps.

P140 *Adaptive Control of Wind Turbine Generator System Based on RBF-PID Neural Network [#N-14280]*

Zhanshan Wang, Zhengwei Shen and Chao Cai, Northeastern University, China

Wind is an intermittent and variable source of energy. Wind speed varies with many factors and is random in magnitude and direction. There are numerous of factors such as temperature, weather, environment and so on that affect wind turbine generator system(WTGS), lead to WTGS cannot ensure the constant output power and the safe operation. For the problem of WTGS with much uncertainty and serious nonlinearity, precise mathematical model based traditional PID controller cannot meet the requirements of pitch control. Advances in wind turbine technology made necessary the design of more powerful control systems. This is in order to improve wind turbines behavior, namely to make them more profitable and more reliable. Thus a radial basis function neural network (RBFNN) based PID pitch control strategy is presented in this paper. The rated speed of the wind turbine given value of generator power is given as the input of the controller. RBFNN is used to be the identifier, giving an identification to pitch system and obtaining the identification information of the system. According to the identification information and the given learning speed, PID parameters are modified on line. The results show that adaptive control based RBF-PID pitch controller has a good performance, possessing the advantages of response fast, small overshoot and high control precision. The Matlab simulation result shows the effectiveness of the proposed methods.

P141 *Single Channel Single Trial P300 Detection Using Extreme Learning Machine, Compared with BPNN and SVM [#N-14067]*

Songyun Xie, You Wu, Yunpeng Zhang, Juanli Zhang and Chang Liu, Northwestern Polytechnical University, China

A Brain Computer Interface (BCI) is a communication system designed to allow the users to directly interact with external devices using their minds without using any muscle activities. P300, a component of Event Related Potentials (ERPs), is a widely used feature component of EEG signal for BCI applications. However, single trial analysis is difficult since ERPs such as P300 signals have a very low signal to noise ratio, which bring down the communication rate. And the numerous number of channels needed to record EEG prevents the popularization of BCI applications due to the complexity and high cost of the system. In this paper, a new efficient method, extreme learning machine (ELM), is presented to detect P300 components using a single channel data from a visual stimuli Oddball paradigm experiment. It reaches an average accuracy above 85% and performs better than BPNN and SVM.

P142 *Spectral Clustering-Based Local and Global Structure Preservation for Feature Selection [#N-14427]*

Sihang Zhou, Xinwang Liu, Chengzhang Zhu, Qiang Liu and Jianping Yin, College of Computer, National University of Defense Technology, China

In this paper, we propose an unsupervised feature selection framework which simultaneously preserves the local geometric structure and global discriminative structure of data. Also, the spectral clustering algorithm is incorporated into this framework to exploit the discriminative structure. To demonstrate the generality of our framework, we instantiate our framework into two specific algorithms by characterizing the local geometric structure of data with two well- known models, i.e., locally linear embedding and linear preserve projection. After that, we provide an efficient algorithm with proved convergence to solve the resultant optimization problem. Comprehensive experiments have been conducted on eleven benchmark data sets and the results demonstrate the superior performance of our framework.

P143 *Unsupervised Robust Bayesian Feature Selection [#N-14240]*

Jianyong Sun and Aimin Zhou, The Abertay University, United Kingdom; East China Normal University, China

In this paper, we proposed a generative graphical model for unsupervised robust feature selection. The model assumes that the data are independent and identically sampled from a finite mixture of Student-t distribution for dealing with outliers. The Student {\em t}-distribution works as the building block for robust clustering and outlier detection. Random variables that represent the features' saliency are included in the model for feature selection. As a result, the model is expected to simultaneously realise unsupervised clustering, feature selection and outlier detection. The inference is carried out by a tree- structured variational Bayes (VB) algorithm. The feature selection capability is realised by estimating the feature saliencies associated with the features. The adoption of full Bayesian treatment in the model realises automatic model selection. Experimental studies showed that the developed algorithm compares favourably against existing unsupervised Bayesian feature selection algorithm in terms of commonly-used internal and external cluster validity indices on controlled experimental settings and benchmark data sets. The controlled experimental study also showed that the developed algorithm is capable of exposing the outliers and finding the optimal number of components (model selection) accurately.

P144 *Competitive Two-Island Cooperative Coevolution for Training Elman Recurrent Networks for Time Series Prediction [#N-14099]*

Rohitash Chandra, University of South Pacific, Fiji

Problem decomposition is an important aspect in using cooperative coevolution for neuro-evolution. Cooperative coevolution employs different problem decomposition methods to decompose the neural network training problem into subcomponents. Different problem decomposition methods have features that are helpful at different stages in the evolutionary process. Adaptation, collaboration and competition are characteristics that are needed for cooperative coevolution as multiple sub-populations are used to represent the problem. It is important to add collaboration and competition in cooperative coevolution. This paper presents a competitive two-island cooperative coevolution method for training recurrent neural networks on chaotic time series problems. Neural level and Synapse level problem decomposition is used in each of the islands. The results show improvement in performance when compared to standalone cooperative coevolution and other methods from literature.

P145 *Universal Approximation Propriety of Flexible Beta Basis Function Neural Tree [#N-14477]*

Souhir Bouaziz, Adel M. Alimi and Ajith Abraham, University of Sfax, Tunisia; Machine Intelligence Research Labs, United States

In this paper, the universal approximation propriety is proved for the Flexible Beta Basis Function Neural Tree (FBBFNT) model. This model is a tree-encoding method for designing Beta basis function neural network. The performance of FBBFNT is evaluated for benchmark problems drawn from time series approximation area and is compared with other methods in the literature.

Monday, July 7, 4:00PM-6:00PM

Special Session: MoN2-1 Concept Drift, Domain Adaptation & Learning in Dynamic Environments I

Monday, July 7, 4:00PM-6:00PM, Room: 308, Chair: Giacomo Boracchi and Manuel Roveri

4:00PM *Trotting Gait Planning for a Quadruped Robot with High Payload Walking on Irregular Terrain [#N-14297]*

Nan Hu, Shaoyuan Li, Dan Huang and Feng Gao, Shanghai Jiao Tong University, China

Walking on irregular terrain is usually a common task for a quadruped robot. It is however difficult to control the robot in this situation as undesirable impulse force by collision between the foot of robot and obstacles makes the robot unstable. This paper presents a Posture Feedback Compensation Controller (PFCC) for a quadruped robot with high payload walking on irregular terrain. In order to make the robot walk stably and fast on irregular terrain, we choose trotting gait for walking. The foot trajectory is scheduled based on the Bezier curve method in order to improve the stability of quadruped robot. Simulations of walking on irregular terrain have been performed. The results have verified that the proposed methods have better stability and higher speed for walking on the irregular terrain.

4:20PM *Using HDDT to Avoid Instances Propagation in Unbalanced and Evolving Data Streams [#N-14424]*

Andrea Dal Pozzolo, Reid Johnson, Olivier Caelen, Serge Waterschoot, Nitesh V. Chawla and Gianluca Bontempi, Universite' Libre de Bruxelles, Belgium; University of Notre Dame, United States; Business Analytics Competence Center, Atos Worldline, Belgium

Hellinger Distance Decision Trees (HDDT) has been previously used for static datasets with skewed distributions. In unbalanced data streams, state-of-the-art techniques use instance propagation and standard decision trees (e.g. C4.5) to cope with the unbalanced problem. However, it is not always possible to revisit/store old instances of a stream. In this paper we show how HDDT can be successfully applied in unbalanced and evolving stream data. Using HDDT allows us to remove instance propagations between batches with several benefits: i) improved predictive accuracy ii) speed iii) single-pass through the data. We use a Hellinger weighted ensemble of HDDTs to combat concept drift and increase accuracy of single classifiers. We test our framework on several streaming datasets with unbalanced classes and concept drift.

4:40PM *Domain Adaptation Bounds for Multiple Expert Systems Under Concept Drift [#N-14833]*

Gregory Ditzler, Gail Rosen and Robi Polikar, Drexel University, United States; Rowan University, United States

The ability to learn incrementally from streaming data - either in an online or batch setting - is of crucial importance for a prediction algorithm to learn from environments that generate vast amounts of data, where it is impractical or simply unfeasible to store all historical data. On the other hand, learning from streaming data becomes increasingly difficult when the probability distribution generating the data stream evolves over time, which renders the classification model generated from previously seen data suboptimal or potentially useless. Ensemble systems that employ multiple classifiers may be used to mitigate this effect, but even in such cases some classifiers (experts) become less knowledgeable for predicting on different domains than others as the distribution drifts. Further complication results when labeled data from a prediction (target) domain is not immediately available; hence, causing prediction on the target domain to yield sub-optimal results. In this work, we provide upper bounds on the loss, which hold with high probability, of a multiple expert system trained in such a nonstationary environment with verification latency. Furthermore, we show why a single model selection strategy can lead to undesirable results when learning in such nonstationary streaming settings. We present our analytical results with experiments on simulated as well as real-world data sets, comparing several different ensemble approaches to a single model.

5:00PM *Core Support Extraction for Learning from Initially Labelled Nonstationary Environments Using COMPOSE [#N-14845]*

Robert Capo, Anthony Sanchez and Robi Polikar, Rowan University, United States

Learning in nonstationary environments, also called concept drift, requires an algorithm to track and learn from streaming data, drawn from a nonstationary (drifting) distribution. When data arrive continuously, a concept drift algorithm is required to maintain an up-to-date hypothesis that evolves with the changing environment. A more difficult problem that has received less attention, however, is learning from so-called initially labeled nonstationary environments, where the the environment provides only unlabeled data after initialization. Since the labels to such data never become available, learning in such a setting is also referred to as extreme verification latency, where the algorithm must only use unlabeled data to keep the hypothesis current. In this contribution, we analyze COMPOSE, a framework recently proposed for learning in such environments. One of the central processes of COMPOSE is core support extraction, where the algorithm predicts which data instances will be useful and relevant for classification in future time steps. We compare two different options, namely Gaussian mixture model based maximum a posteriori sampling and alpha-shape compaction, for core support extraction, and analyze their effects on both accuracy and computational complexity of the algorithm. Our findings point to - as is the case in most engineering problems - a trade-off: that alpha-shapes are more versatile in most situations, but they are far more computationally complex, especially as the dimensionality of the dataset increases. Our proposed GMM procedure allows COMPOSE to operate on datasets of substantially larger dimensionality without affecting its classification performance.

5:20PM *Optimal Bayesian Classification in Nonstationary Streaming Environments [#N-14855]*

Jehandad Khan, Nidhal Bouaynaya and Robi Polikar, Rowan University, United States

A novel method of classifying data drawn from a nonstationary distribution with drifting mean and variance is presented. The novelty of the approach is based on splitting the problem of tracking a nonstationary distribution into separate classification and time series state estimation problems. State space models for drift in both the mean and variance are presented, which are then successfully tracked using a Kalman filter and a particle filter for the linear and non-linear parts respectively. Preliminary results, which show the promising potential of the approach, are also presented, along with concluding remarks for potential uses of the proposed approach.

5:40PM *New Untrained Aggregation Methods for Classifier Combination [#N-14696]*

Bartosz Krawczyk and Michal Wozniak, Wroclaw University of Technology, Poland

The combined classification is a promising direction in pattern recognition and there are numerous methods that deal with forming classifier ensembles. The most popular approaches employ voting, where the final decision of compound classifier is a combination of individual classifiers' outputs, i.e., class labels or support functions. This paper concentrates on the problem how to design an effective combination rule, which takes into consideration the values of support functions returned by the individual classifiers. Because in many practical tasks we do not have a training set at our disposal, then we express our interest in aggregation methods which do not require learning. A special attention is paid to weighted aggregation, especially when the different weights depend on particular support function of a given individual classifier. We propose a novel approach for untrained combination of support functions using the Gaussian function to assign mentioned above weights. The computer experiments carried out on the set of benchmark data sets confirm the advantages of the proposed approach for particular cases, especially when the number of class labels is high.

Special Session: MoN2-2 Applications of Computational Intelligence in Ecological Informatics and Environmental Modelling

Monday, July 7, 4:00PM-6:00PM, Room: 305A, Chair: Mike Watts and Jie Yang

4:00PM *Spatio-Temporal PM2.5 Prediction by Spatial Data Aided Incremental Support Vector Regression [#N-14253]*

Lei Song, Shaoning Pang, Ian Longley, Gustavo Olivares and Abdolhossein Sarrafzadeh, Unitec Institute of Technology, New Zealand; The National Institute of Water and Atmospheric Research, New Zealand

Machine learning requires sufficient and reliable data to enhance the performance. Yet environmental data sometimes is short and/or contains missing data. This makes existing prediction models built on machine learning often fail to predict environmental problems accurately. We argue that spatial domain data can be used also for the training of a temporal prediction model. This paper formulates mathematically a spatial data aided incremental support vector regression (SaIncSVR) for spatio-temporal PM2.5 prediction. We conducted spatio-temporal PM2.5 prediction over 13 monitoring stations in Auckland New Zealand, and compared the proposed SaIncSVR with a pure temporal IncSVR prediction.

4:20PM *Estuarine Flood Modelling Using Artificial Neural Networks [#N-14520]*

Seyyed Adel Alavi Fazel, Hamid Mirfenderesk, Michael Blumenstein and Rodger Tomlinson, Griffith University, Australia

Prediction of water levels at estuaries poses a significant challenge for modelling of floods due to the influence of tidal effects. In this study, a two-stage forecasting system is proposed. In the first stage, the tidal portion of the available records is used to develop a tidal prediction system. The predictions of the first stage are used for flood modelling in the second. Experimental results suggest that the proposed flood modelling approach is advantageous for forecasting flood levels with more than 1 hour lead times.

4:40PM *NeuCube(ST) for Spatio-Temporal Data Predictive Modelling with a Case Study on Ecological Data [#N-14538]*

Enmei Tu, Nikola Kasabov, Muhaini Othman, Yuxiao Li, Susan Worner, Jie Yang and Zhenghong Jia, Shanghai Jiao Tong University, China; Auckland University of Technology, New Zealand; Lincoln University, New Zealand; Xinjiang University, China

Early event prediction challenges most of existed modeling methods because especially when dealing with complex spatio-temporal data. In this paper we propose a new method for predictive data modelling based on a new development of the recently proposed NeuCube [9,10] spiking neural network architecture, called here NeuCube(ST). The NeuCube is using spiking neural network reservoir (SNNr) and dynamic evolving spiking neuron network (deSNN) classifier. NeuCube(ST) is an integrated environment including data conversion into spike trains, input variable mapping, unsupervised learning in the SNNr, supervised classification learning, activity visualization and network structure analysis. A case study on real world ecological data set is also presented to demonstrate the validity of the proposed method.

5:00PM *Evolving Connectionist Systems Can Predict Outbreaks of the Aphid Rhopalosiphum Padi [#N-14603]*

Michael Watts, Auckland Institute of Studies, New Zealand

Modeling of insect pest outbreaks is important for the protection of economically significant crops. This paper describes an attempt to model the outbreaks of the aphid Rhopalosiphum padi in the Canterbury region of New Zealand. Outbreaks were predicted using two representations of weather variables: Firstly, from moving time windows over the variables; Secondly, from the gradient or rate of change of the variables, which is presented here for the first time. Two artificial neural network types were used in this modeling, Multi-Layer Perceptrons (MLP) and Simple Evolving Connectionist Systems (SECoS). The results show that while SECoS are able to predict outbreaks of R. padi from either approach, MLP are unable to do so. Also, the results show that there is no significant difference in the modeling accuracy of SECoS between either modeling approach. These results indicate that the rate of change of weather variables is as important to the prediction of aphid outbreaks as the values of those variables. This work represents the first steps towards an outbreak prediction system that can assist with the management of these crop pests.

5:20PM *Support Vector Regression of Multiple Predictive Models of Downward Short-Wave Radiation [#N-14700]*

Pavel Kromer, Petr Musilek, Emil Pelikan, Pavel Krc, Pavel Jurus and Krystof Eben, University of Alberta, Canada; Academy of Sciences of the Czech Republic, Czech Republic

Accurate forecasts of weather conditions are of the utmost importance for the management and operation of renewable energy sources with intermittent (stochastic) production. With the growing amount of intermittent energy sources, the need for precise weather predictions increases. Production of energy from renewable power sources, such as wind and solar, can be predicted using numerical weather prediction models. These models can provide high- resolution, localized forecast of wind speed and solar irradiation. However, different instances of numerical weather prediction models may provide different forecasts, depending on their properties and parameterizations. To alleviate this problem, it is possible to employ multiple models and to combine their outputs to obtain more accurate localized forecasts. This work uses the machine- learning tool of Support Vector Regression to amalgamate downward short-wave radiation forecasts of several numerical weather prediction models. Results of SVR-based multi-model forecasts of irradiation at a large set of locations show a significant improvement of prediction accuracy.

5:40PM *Applying Computational Intelligence Methods to Modeling and Predicting Common Bean Germination Rates [#N-14756]*

Andre Bianconi, Michael Watts, Yanbo Huang, A. B. S. Serapiao, Jose Silvio Govone, X. Mi, Gustavo Habermann and Alessandro Ferrarini, International Academy of Ecology and Environmental Sciences, Brazil; Auckland Institute of Studies, New Zealand; United States Department of Agriculture, United States; IGCE-DEMAC-Unesp, Brazil; State Key Laboratory of Vegetation and Environmental Change, Institute of Botany Chinese Academy of Sciences, China; Instituto de Biociencias, Unesp, Brazil; The University of Parma, Italy

The relationship between seed germination rate and environmental temperature is complex. This study assessed the effectiveness of multi-layer perceptron (MLP) and Particle Swarm Optimization (PSO) techniques in modeling and predicting the germination rate of two common bean cultivars as a function of distinct temperatures. MLP was utilized to model the germination rate of the cultivars and PSO was employed to determine the optimum temperatures at which the beans germinate most rapidly. The outcomes derived from implementing the MLP were compared with those obtained by means of a traditional statistical method. The MLP provided more accurate results than the conventional statistical regression in predicting germination rate values regarding the two common bean cultivars. The optimum germination rate values derived from implementing the PSO model were more accurate than those obtained by using the conventional quadratic regression.

6:00PM *Contamination Event Detection in Drinking Water Systems Using a Real-Time Learning Approach [#N-14955]*

Demetrios Eliades, Christos Panayiotou and Marios Polycarpou, University of Cyprus, Cyprus

In this work we present the problem of contamination event detection in drinking water distribution networks, using real-time learning approaches and a model- based event detection scheme. By using chlorine concentration measurements, a contamination event detection algorithm is developed with the aim of detecting the occurrence of contaminant injection into a water tank, by monitoring the change of the chlorine concentration. The proposed methodology is comprised of two steps: a) learn in real-time the unknown chlorine reaction dynamics using a Radial-Basis Function network; b) activate a contamination-event detection methodology which uses an adaptive detection threshold. A contamination event detection alarm is activated when the magnitude of the estimation error exceeds the detection threshold. To demonstrate the proposed methodology, a realistic case study is evaluated with Monte-Carlo simulations of contamination events of different magnitudes, occurrence times and environmental characteristics. The results demonstrate the improvement in the contamination event detection performance when using the real-time learning approach.

Special Session: MoN2-3 Mind, Brain, Development and Cognitive Algorithms

Monday, July 7, 4:00PM-6:00PM, Room: 305B, Chair: Angelo Cangelosi and Leonid Perlovsky

4:00PM *Cognitive Functions of Aesthetic Emotions [#N-14131]*

Leonid Perlovsky, Harvard University, United States

The paper introduces a scientific definition of "aesthetic" emotions compatible with known working of the mind. These are emotions related to knowledge and to satisfaction of instinct for knowledge. Cognitive and mathematical model arguments are presented that aesthetic emotions motivate us to acquire and improve knowledge. Near the top of the mental hierarchy they are experienced as the beautiful. Contradictions in knowledge experienced as emotions of cognitive dissonances interfere with acquiring knowledge. Overcoming cognitive dissonances is necessary for accumulating knowledge and sustaining human evolution. A multiplicity of aesthetic emotions required for overcoming cognitive dissonances are created by music; this is the evolutionary purpose of musical ability.

4:20PM *Locality Linear Fitting One-Class SVM with Low-Rank Constraints for Outlier Detection [#N-14138]*

Sheng Li, Ming Shao and Yun Fu, Northeastern University, United States

We propose a novel outlier detection approach in this paper, which learns the most accurate hyperspheres for the normal data through a top-down procedure. Conventional one-class support vector machine (SVM) based approaches aim to find nonlinear global solutions for all the normal data, with the benefit of kernel trick. However, those methods are intractable when data

are in large-scale and inaccurate when data are under complex distributions. It's observed that high dimensional data, e.g., features of texts or images, are always sparse, and linear classifier usually performs well. A specific class of data seldom lie in one single subspace. In this paper, we propose to learn multiple discriminative hyper-spheres locally based on the data distributions, and fit them globally to formulate a more discriminative boundary for the normal data. By far, neural mechanisms used by human brain-mind for outlier detection are not known, however, the top-down strategy proposed in this paper would inspire understanding of the human neural mechanisms. The benefits of our model are two- folds. First, the distribution of each local cluster is much simpler than that in a global view, which makes the fitting processing for each individual cluster much easier and insensitive to the choice of kernel. In particular, we adopt low-rank constraints to find multiple clusters automatically. Secondly, the proposed approach trains the model linearly which tackles the large-scale problem, substantially reducing training time and memory space. Extensive experimental results on three image databases demonstrate that our approach outperforms several related methods.

4:40PM *Learning to Interact and Interacting to Learn: Active Statistical Learning in Human-Robot Interaction [#N-14513]*

Chen Yu, Tian Xu, Yiwen Zhong, Seth Foster and Hui Zhang, Indiana University, United States; Fujian Agriculture and Forestry University, China

Learning and interaction are viewed as two related but distinct topics in developmental robotics. Many studies focus solely on either building a robot that can acquire new knowledge and learn to perform new tasks, or designing smooth human-robot interactions with pre-acquired knowledge and skills. The present paper focuses on linking language learning with human-robot interaction, showing how better human-robot interaction can lead to better language learning by robot. Toward this goal, we developed a real-time human-robot interaction paradigm in which a robot learner acquired lexical knowledge from a human teacher through free-flowing interaction. With the same statistical learning mechanism in the robot's system, we systematically manipulated the degree of activity in human-robot interaction in three experimental conditions: the robot learner was either highly active with lots of speaking and looking acts, or moderately active with a few acts, or passive without actions. Our results show that more talking and looking acts from the robot, including those immature behaviors such as saying non- sense words or looking at random targets, motivated human teachers to be more engaged in the interaction. In addition, more activities from the robot revealed its robot's internal learning states in real time, which allowed human teachers to provide more useful and "on-demand" teaching signals to facilitate learning. Thus, compared with passive and batch-mode training, an active robot learner can create more and better training data through smooth and effective social interactions that consequentially lead to more successful language learning.

5:00PM *The iCub Learns Numbers: An Embodied Cognition Study [#N-14672]*

Alessandro Di Nuovo, De La Cruz Vivian, Angelo Cangelosi and Santo Di Nuovo, Plymouth University, United Kingdom; Messina University, Italy; Catania University, Italy

Thanks to recent technological advances and the increasing interest towards the Cognitive Developmental Robotics (CDR) paradigm, many popular platforms for scientific research have been designed in order to resemble the shape of the human body. The motivation behind this strongly humanoid design is the embodied cognition hypothesis, which affirms that all aspects of cognition are shaped by aspects of the body. Thus CDR is based on a synthetic approach that aims to provide new understanding on how human beings develop their higher cognitive functions. Following this paradigm we have developed an artificial model, based on artificial neural networks, to explore finger counting and the association of number words (or tags) to the fingers, as bootstrapping for the representation of numbers in the humanoid robot iCub. In this paper, we detail experiments of our model with the iCub robotic platform. Results of the number learning with proprioceptive data from the real platform are reported and compared with the ones obtained instead, with the simulated platform. These results support the thesis that learning the number words in sequence, along with finger configurations helps the building of the initial representation of number in the robot. Moreover, the comparison between the real and simulated iCub gives insights on the use of these platforms as a tool for CDR.

5:20PM *Predictive Hebbian Association of Time-Delayed Inputs with Actions in a Developmental Robot Platform [#N-14723]*

Martin F. Stoelen, Davide Marocco, Angelo Cangelosi, Fabio Bonsignorio and Carlos Balaguer, Universidad Carlos III de Madrid, Spain; University of Plymouth, United Kingdom

The work described here explores a neural network architecture that can be embedded directly in the real-time sensorimotor coordination loop of a developmental robot platform. We take inspiration from the way children are able to learn while interacting with a teacher, in particular the use of prediction of the teacher actions to improve own learning. The architecture is based on two neural networks that operate online, and in parallel, one for learning and one for prediction. A Hebbian learning rule is used to associate the high-dimensional afferent sensor input at different time-delays with the current efferent motor commands corresponding to the teacher demonstration. The predictions of future motor commands are used to limit the growth of the neural network weights, and to enable the robot to smoothly continue movements the teacher has begun. Results on a simulated iCub robot learning object interaction tasks are presented, including an analysis of the sensitivity to changes in the task setup. We also outline the first implementation on the real iCub platform.

5:40PM *A Developmental Perspective on Humanoid Skill Learning Using a Hierarchical SOM-Based Encoding [#N-14819]*

Georgios Pierris and Torbjorn Dahl, University of South Wales, United Kingdom; Plymouth University, United Kingdom

Hand-coding is an impractical approach to developing motion repertoires for humanoid robots, requiring both task and programming expertise. Physical demonstration of skills, on the other hand, is an approach with which humans are both competent and familiar. When following a programming-by-demonstration approach, the adaptiveness of a robot can be further increased by giving it the ability to compose novel skills from skills already acquired from demonstration. We have previously presented an extension to the Piaget-inspired Constructivist Learning Architecture, featuring a hierarchical SOM-based algorithm that encodes skills as a hierarchy of fixed-length subsequences. At the core of the extended algorithm lies a novel principle for comparing long-term memory and short-term memory, represented as connection weights and decaying node activation values, respectively. In this article, we present an in-depth analysis of how this comparison, can provide a robot control algorithm that is both state-sensitive and goal oriented. We present results from experiments using an abstract chain walk problem that includes hidden states, to demonstrate how the algorithm disambiguates states and selects actions yielding higher rewards. Furthermore, we present results from an experiment where we use programming-by- demonstration to encode and reproduce a figure-8 gesture with a Nao humanoid robot. The results show that our algorithm is capable of identifying hidden states in both real and abstract problem domains.

6:00PM *WWN-9: Cross-Domain Synaptic Maintenance and Its Application to Object Groups Recognition [#N-14927]*

Qian Guo, Xiaofeng Wu and Juyang Weng, Fudan University, China; Michigan State University, United States

WWN-6 has shown that its model of synaptic maintenance using neural transmitters ACh and NE enables each neuron to distinguish between neuronal input lines from its relatively stable object patch and those from irrelevant backgrounds. However, it is about only a single domain --- sensory domain X. During development from conception through fetus and newborn, every brain neuron has three major domains of input, sensory X, lateral Y and motor Z. The single- domain model of WWN-6 is not directly applicable to multiple domains because different domains have very different dimension and signal variations that cannot be directly compared. We believe that cross-domain synaptic maintenance is a crucial mechanism to develop a shallow-and-deep processing hierarchy in the brain where each neuron autonomously select domains in the developing hierarchy, not necessarily directly connected to receptors in X and muscles in Z. In the new work here, we propose a biologically inspired model for cross-domain synaptic maintenance. We assume that the earlier connection guided by morphogen result in initial coarse connection, but cross-domain synaptic maintenance refine connections to enable each neuron to autonomously find its role. Experimentally, we show the effect of the new theory through learning of individual objects and object groups, where neurons initialized for object-group connections tend to find their receptor inputs from X are not as stable as inputs from motor Z, thus, gradually turn into ``later'' processing neurons --- for ``higher-level'' object-based features and their invariances. In principle, WWN-9 tends to learn a new object group without repeating the learning of all instances of each individual object.

MoN2-4 Real World Applications I

Monday, July 7, 4:00PM-6:00PM, Room: 305C, Chair: Danil Prokhorov

4:00PM *Tagging Documents Using Neural Networks Based on Local Word Features [#N-14149]*

Arnulfo Azcarraga, Paolo Tensuan and Rudy Setiono, De La Salle University, Philippines; National University of Singapore, Singapore

Keywords and key-phrases that concisely represent text documents are integral to many knowledge management and text information retrieval systems, as well as digital libraries in general. Not all text documents, however, are annotated with good keywords; and the quality of these keywords is often dependent on a tedious, sometimes manual, extraction and tagging process. To automatically extract high quality keywords without the need for a semantic analysis of the document, it is shown that artificial neural networks (ANN) can be trained to only consider in-document word features such as word frequency, word distribution in document, use of word in special parts of the document, and use of word formatting features (i.e. bold-faced, italicized, large-font size). Results show that purely local features are adequate in determining whether a word in a document is a keyword or not. Classification performance yields a G mean of a least 0.83, and weighted f-measure of 0.96 for both keywords and non- keywords. Precision for keywords alone, however, is not as high. To understand the basis for classifying keywords, C4.5 is used to extract rules from the ANN. The extracted rules from C4.5, in the form of a decision tree, show the relative importance of the different document features that were extracted.

4:20PM *Constraint Online Sequential Extreme Learning Machine for Lifelong Indoor Localization System [#N-14334]*

Yang Gu, Junfa Liu, Yiqiang Chen and Xinlong Jiang, Institute of Computing Technology, Chinese Academy of Sciences, China

As an important technology in LBS (Location Based Services) field, Wi-Fi based indoor localization suffers signal fluctuation problem which prevents lifelong and high performance running. With the fluctuation of wireless signal over time, fingerprints collected at the same location become different; therefore existing model cannot fit the new collected data well, which decreases the localization accuracy. In this paper, a novel indoor localization method COSELM (Constraint Online Sequential Extreme Learning Machine) is proposed, utilizing incremental data to update the old model and overcome the fluctuation problem. The performance of COSELM is validated in real Wi-Fi indoor environment. Compared with OSELM, it can improve more than 5% localization accuracy on average; and in contrast to batch learning, COSELM can save more than 50% time consumption.

4:40PM *Intelligent Facial Action and Emotion Recognition for Humanoid Robots [#N-14440]*

Li Zhang, Ming Jiang and Alamgir Hossain, Northumbria University, United Kingdom; Leeds University, United Kingdom

This research focuses on the development of a real-time intelligent facial emotion recognition system for a humanoid robot. In our system, Facial Action Coding System is used to guide the automatic analysis of emotional facial behaviours. The work includes both an upper and a lower facial Action Units (AU) analyser. The upper facial analyser is able to recognise six AUs including Inner and Outer Brow Raiser, Upper Lid Raiser etc, while the lower facial analyser is able to detect eleven AUs including Upper Lip Raiser, Lip Corner Puller, Chin Raiser, etc. Both of the upper and lower analysers are implemented using feedforward Neural Networks (NN). The work also further decodes six basic emotions from the recognised AUs. Two types of facial emotion recognisers are implemented, NN-based and multi-class Support Vector Machine (SVM) based. The NN-based facial emotion recogniser with the above recognised AUs as inputs performs robustly and efficiently. The Multi-class SVM with the radial basis function kernel enables the robot to outperform the NN-based emotion recogniser in real-time posed facial emotion detection tasks for diverse testing subjects.

5:00PM *Speaker Verification with Deep Features [#N-14524]*

Yuan Liu, Tianfan Fu, Yuchen Fan, Yanmin Qian and Kai Yu, Shanghai Jiao Tong University, China

Due to great success of deep learning in speech recognition, there has been interest of applying deep learning to speaker verification. Previous investigations usually focus on using deep neural network as new classifiers or to extract speaker dependent features. They are either not compatible with existing speaker verification approaches, or not able to achieve significant performance gain in large scale tasks. Also, all the previous approaches have not addressed the issue of how to make use of extra unsupervised data. This paper proposes a novel feature engineering approach within the deep learning framework for speaker verification. Hidden layer output of deep neural network or deep belief network trained on large amount of speech recognition data are extracted as deep features. These features are then used in a Tandem fashion or concatenated with the original acoustic features for GMM-UBM speaker verification. The proposed approach can make use of large amount of existing speech recognition data without speaker labels and is easy to be combined with other mature classification approaches. Experiments on the core condition of NIST 2006 SRE showed that, in a text independent task, the proposed approach can achieve 12.8% relative EER improvement compared to the standard GMM-UBM systems. In addition, text-dependent speaker verification experiments were also performed and yielded similar significant gain.

5:20PM *Qualitative Approach for Inverse Kinematic Modeling of a Compact Bionic Handling Assistant Trunk [#N-14900]*

Achille Melingui, Rochdi Merzouki, Jean Bosco Mbede, Coralie Escande, Boubaker Daachi and Nabil Benoudjit, University of Lille1, France; University of Yaounde 1, Cameroon; LISSI laboratory, France; University of Batna, Algeria

Compact Bionic Handling Assistant (CBHA) is a continuum manipulator, with pneumatic-based actuation and compliant gripper. This bionic arm is attached to a mobile robot named Robotino. Inspired by the elephant's trunk, it can reproduce biological behaviors of trunks, tentacles, or snakes. Unlike rigid link robot manipulators, the development of high performance control algorithm of continuum robot manipulators remains a challenge, particularly due to their complex mechanical design, hyper-redundancy and presence of uncertainties. Numerous studies have been investigated for modeling of such complex systems. Such continuum robots, like the CBHA present a set of nonlinearities and uncertainties, making difficult to build an accurate analytical model, which can be used for control strategies development. Hence, learning approach becomes a suitable tool in such scenarios in order to capture un-modeled nonlinear behaviors of the continuous robots. In this paper, we present a qualitative modeling approach, based on neuronal model of the inverse kinematic of CBHA. A penalty term constraint is added to the inverse objective function into Distal Supervised Learning (DSL) scheme to select one particular inverse model from the redundancy manifold. The inverse kinematic neuronal model is validated by conducting a real-time implementation on a CBHA trunk.

5:40PM *Automatic Cluster Labeling through Artificial Neural Networks [#N-14907]*

Lucas Lopes, Vinicius Machado and Ricardo Rabelo, Federal University of Piaui, Brazil

The clustering problem has been considered as one of the most important problems among those existing in the research area of unsupervised learning (a Machine Learning subarea). Although the development and improvement of algorithms that deal with this problem has been focused by many researchers, the main goal remains undefined: the understanding of generated clusters. As important as identi-fying clusters is to understand its meaning. A good cluster definition means a relevant understanding and can help the specialist to study or interpret data. Facing the problem of comprehend clusters - in other words, create labels - this paper presents a methodology to automatic labeling clusters based on techniques involving supervised and unsupervised learning plus a discretization model. Considering the problem from its inception, the problem of understanding clusters is dealt similar to a real problem, being initialized from clustering data. For this, an unsupervised learning technique is applied and then a supervised learning algorithm will detect which are the relevant attributes in order to define a specific cluster. Additionally, some strategies are used to create a methodology that presents a label (based on attributes and their values) for each cluster provided. Finally, this methodology is applied in four distinct databases presenting good results with an average above 88.79% of elements correctly labeled.

MoN2-5 Feedforward Neural Networks I

Monday, July 7, 4:00PM-6:00PM, Room: 305D, Chair: Meng Joo Er

4:00PM *A Fast and Effective Extreme Learning Machine Algorithm without Tuning [#N-14064]*

Meng Joo Er, Zhifei Shao and Ning Wang, Nanyang Technological University, Singapore; Dalian Maritime University, China

Artificial Neural Networks (ANN) is a major machine learning technique inspired by biological neural networks. However, the process of its parameter tuning is usually tedious and time consuming, and thus it becomes a major bottleneck for it being efficiently applied and used by nonexperts. In this paper, a novel ANN algorithm, termed as Automatic Regularized Extreme Learning Machine(AR-ELM), based on a Regularized Extreme Learning Machine (RELM) using ridge regression is proposed. It is a true automatic ANN learning algorithm in the sense that it can automatically identify the appropriate essential system parameter according to the input data without the need of user intervention. Since this method is based on a relatively straightforward formula, it can achieve very fast learning speed. The simulation results shows that the proposed AR-ELM algorithm can achieve comparable results to tedious cross-validation tuned RELM. Furthermore, we also systematically investigate one of the biggest concerns of ELM, its randomness nature, caused by randomly generated parameters.

4:20PM *Aggregation of PI-Based Forecast to Enhance Prediction Accuracy [#N-14157]*

Mohammad Anwar Hosen, Abbas Khosravi, Saeid Nahavandi and Douglas Creighton, Deaking University, Australia

In contrast to point forecast, prediction interval-based neural network offers itself as an effective tool to quantify the uncertainty and disturbances that associated with process data. However, single best neural network (NN) does not always guarantee to predict better quality of forecast for different data sets or a whole range of data set. Literature reported that ensemble of NNs using forecast combination produces stable and consistence forecast than single best NN. In this work, a NNs ensemble procedure is introduced to construct better quality of PIs. Weighted averaging forecasts combination mechanism is employed to combine the PI-based forecast. As the key contribution of this paper, a new PI-based cost function is proposed to optimize the individual weights for NN in combination process. An optimization algorithm, named simulated annealing (SA) is used to minimize the PI-based cost function. Finally, the proposed method is examined in two different case studies and compared the results with the individual best NNs and available simple averaging PIs aggregating method. Simulation results demonstrated that the proposed method improved the quality of PIs than individual best NNs and simple averaging ensemble method. \end{abstract}

4:40PM *GPU Implementation of the Feedforward Neural Network with Modified Levenberg-Marquardt Algorithm [#N-14199]*

Tomislav Bacek, Dubravko Majetic and Danko Brezak, Faculty of Mechanical Engineering and Naval Architecture, Croatia

In this paper, an improved Levenberg-Marquardt- based feedforward neural network, with variable weight decay, is suggested. Furthermore, parallel implementation of the net- work on graphics processing unit is presented. Parallelization of the network is achieved on two different levels. First level of parallelism is data set level, where parallelization is possible due to inherently parallel structure of the feedforward neural networks. Second level of parallelism is Jacobian computation level. Third level of parallelism, i.e. parallelization of optimiza- tion search steps, is not implemented due to the variable weight decay, which makes third level of parallelism redundant. Sug- gested weight decay variation enables the compromise between higher accuracy with oscillations on one side and stable, but slower convergence on the other. To improve learning speed and efficiency, modification of random weight initialization is included. Testing of proposed algorithm is performed on two real domain benchmark problems. The results obtained and presented in this paper show effectiveness of proposed algorithm implementation.

5:00PM *Coarse and Fine Learning in Deep Networks [#N-14218]*

Anthony Knittel and Alan Blair, University of New South Wales, Australia

Evolutionary systems such as Learning Classifier Systems (LCS) are able to learn reliably in irregular domains, while Artificial Neural Networks (ANNs) are very successful on problems with an appropriate gradient. This study introduces a novel method for discovering coarse structure, using a technique related to LCS, in combination with gradient descent. The structure used is a deep feature network, with a number of properties of a higher level of abstraction than existing ANNs, for example the network is constructed based on co-occurrence relationships, and maintained as a dynamic population of features. The feature creation technique can be considered a coarse or rapid initialization technique, that constructs a network before subsequent fine-tuning using gradient descent. The approach we introduce is a general learning technique, with assumptions of the dimensionality of input, and the described method uses convolved features. It does not require the same domain assumptions and pre-defined topology used by Convolutional Neural Networks, although the approach is less general than Restricted Boltzmann Machine approaches. Results of classification of MNIST images show an average error rate of 0.79% without pre-processing or pre-training, comparable to the benchmark result provided by RBM techniques of 0.95%, and 0.79% using dropout, however based on a convolutional topology. Use of a randomly initialized network provides a poorer result (1.25%) indicating the coarse learning process plays a significant role. Development of higher level relationships between features using this approach offers a distinct method of learning using a deep network of features, that can be used in combination with existing techniques.

5:20PM *Constrained Extreme Learning Machine: A Novel Highly Discriminative Random Feedforward Neural Network [#N-14616]*

Wentao Zhu, Jun Miao and Laiyun Qing, Institute of Computing Technology, Chinese Academy of Sciences, China; University of Chinese Academy of Sciences, China

In this paper, a novel single hidden layer feedforward neural network, called Constrained Extreme Learning Machine (CELM), is proposed based on Extreme Learning Machine (ELM). In CELM, the connection weights between the input layer and hidden neurons are randomly drawn from a constrained set of difference vectors of between-class samples, rather than an open set of arbitrary vectors. Therefore, the CELM is expected to be more suitable for discriminative tasks, whilst retaining other advantages of ELM. The experimental results are presented to show the high efficiency of the CELM, compared with ELM and some other related learning machines.

5:40PM *Self-Learning Recursive Neural Networks for Structured Data Classification [#N-14687]*

Bouchachia Abdelhamid, Bournemouth University, United Kingdom

Automatic classification of structured data is a challenging task and its relevance to many domains is evident. However, collecting labeled data may turn to be a quite expensive task and sometimes even prone to mislabeling. A technical solution to this problem consists in combining few labeled data samples and a significant amount of unlabeled data samples to train a classifier. Likewise, the present paper deals with the classification of partially labeled tree-like structured data. To carry on this task, we suggest an adapted variant of recursive neural networks (RNNs) that is equipped with semi-supervision mechanisms capable of learning from labeled and unlabeled tree-like data. Accordingly RNNs rely on self-learning to actively pre-label data which will be combined with originally labeled one during the learning process. The semi-supervised RNNs approach is presented and evaluated on real-world eXtensible Markup Language (XML) collection of documents in the context of digital libraries. The initial empirical experiments show high quality results.

MoN2-6 Time Series Analysis II

Monday, July 7, 4:00PM-6:00PM, Room: 305E, Chair: Eros Pasero

4:00PM *Data-Aware Remaining Time Prediction of Business Process Instances [#N-14002]*

Mirko Polato, Alessandro Sperduti, Andrea Burattin and Massimiliano de Leoni, University of Padua, Italy

Accurate prediction of the completion time of a business process instance would constitute a valuable tool when managing processes under service level agreement constraints. Such prediction, however, is a very challenging task. A wide variety of factors could influence the trend of a process instance, and hence just using time statistics of historical cases cannot be sufficient to get accurate predictions. Here we propose a new approach where, in order to improve the prediction quality, both the control and the data flow perspectives are jointly used. To achieve this goal, our approach builds a process model which is augmented by time and data information in order to enable remaining time prediction. The remaining time prediction of a running case is calculated combining two factors: (a) the likelihood of all the following activities, given the data collected so far; and (b) the remaining time estimation given by a regression model built upon the data.

4:20PM *Forecasting Hourly Electricity Load Profile Using Neural Networks [#N-14202]*

Mashud Rana, Irena Koprinska and Alicia Troncoso, University of Sydney, Australia; University Pablo de Olavide, Spain

We present INN, a new approach for predicting the hourly electricity load profile for the next day from a time series of previous electricity loads. It uses an iterative methodology to make the predictions for the 24-hour forecasting horizon. INN combines an efficient mutual information feature selection method with a neural network forecasting algorithm. We evaluate INN using two years of electricity load data for Australia, Portugal and Spain. The results show that it provides accurate predictions, outperforming three state-of-the-art approaches (weighted nearest neighbor, pattern sequence similarity and iterative linear regression), and a number of baselines. INN is also more accurate and efficient than a non-iterative version of the approach. We also found that although the range of load values for the three countries is very different, the load curves show similar patterns, which resulted in more than 90% overlap in the selected lag variables.

4:40PM *Time Series Forecasting via Weighted Combination of Trend and Seasonality Respectively with Linearly Declining Increments and Multiple Sine Functions [#N-14380]*

Wenchao Lao, Ying Wang, Chen Peng, Chengxu Ye and Yunong Zhang, Sun Yat-sen University, China; Qinghai Normal University, China

In this paper, a novel weighted-combination-of-components (WCC) method is proposed for modeling and forecasting trend and seasonal time series, and such a method is based on decomposition model which regards the time series as the weighted combination of trend, seasonality and other components. Specifically, the Holt's two-parameter exponential smoothing (HTPES) method is improved (for short, the IHTPES method) to evaluate the trend with linearly declining increments; and the multiple sine functions decomposition (MSFD) method is developed to evaluate the seasonality. Then the weighted combination of the evaluations is obtained to estimate the global time series. Numerical experiment results substantiate the effectiveness and superiority of the proposed WCC method in terms of modeling and forecasting time series from the NN3 competition.

5:00PM *A Factor - Artificial Neural Network Model for Time Series Forecasting: The Case of South Africa [#N-14611]*

Ali Babikir and Henry Mwambi, University of KwaZulu-Natal, South Africa

Artificial Neural Networks (ANNs) are flexible nonlinear models that can approximate virtually any function to any desired degree of accuracy. Theoretical and empirical results support the effectiveness of the integration of different models to improve forecast performance. In this paper, the factor models (FMs) are integrated with the ANN model to produce a new hybrid method which we refer to as the Factor Artificial Neural Network (FANN) to improve the time series forecasting performance of the artificial neural networks. The empirical results of the Root Mean Square Error RMSE for the in sample and out of sample forecasts from 2007:01 to 2011:12 indicate that the proposed FANN model is an effective way to improve forecasting accuracy over the dynamic factor Model (DFM), the ANN and AR benchmark model. The results confirm the usefulness of the factors that were extracted from a large set of related variables when we compare the FANN and ANN models. On the other hand, as far as estimation is concerned the nonlinear FANN model is more suitable to capture nonlinearity and structural breaks compared to linear models. The Diebold- Mariano test results confirm the superiority of the FANN model forecasts performance over the AR benchmark model and the ANN model forecasts

5:20PM *A Neural Network Based Approach to Support the Market Making Strategies in High-Frequency Trading [#N-14730]*

Everton Silva, Douglas Castilho, Adriano Pereira and Humberto Brandao, Federal University of Minas Gerais, Brazil; Federal University of Alfenas, Brazil

Artificial Neural Networks (ANN) have been frequently applied to reduce risks and maximize the net returns in different types of algorithm trading. Using a real data set, and aiming to support the Market Making process in High-Frequency Trading, this work investigates the use of a multilayer perceptron (MLP) to predict positive oscillations in short time periods (5, 10 or 15 minutes). The statistical analysis of our results showed that a neural network is more effective in short-term oscillations (5 minutes) when compared with the results obtained in longer periods (10 or 15 minutes). The result is important because it allows to insert a higher quantity of limit orders once they will be placed more frequently, which increases the market liquidity. It contextualizes a new contribution in the High-Frequency Trading field, where this work proposes a new trigger to start a market making process.

5:40PM *A Monte Carlo Strategy for Structured Multiple-Step-Ahead Time Series Prediction [#N-14468]*

Gianluca Bontempi, Universite Libre de Bruxelles, Belgium

Forecasting a time series multiple-step-ahead is a challenging problem for several reasons: the accumulation of errors, the noise, and the complexity of the dependency between past and far future which has to be inferred on the basis of a limited amount of data. Traditional approaches to multi-step- ahead forecasting reduce the problem to a series of single-output prediction tasks. This is notably the case of the Iterated and the Direct approaches. More recently, multiple- output approaches appeared and stressed the multivariate and structured nature of the output to be predicted. This paper intends to go a step further in this direction by formulating the problem of multi-step-ahed forecasting as a problem of conditional multivariate estimation which can be addressed by a Monte Carlo importance sampling strategy. The interesting aspect of the approach is that this probabilistic formulation allows a natural integration of the traditional Iterated and Direct approaches. The extensive assessment of our algorithm with the NN5, NN3 and a synthetic benchmark shows that this approach is promising and competitive with the state-of-the-art.

MoN2-7 Hybrid Learning Methods

Monday, July 7, 4:00PM-6:00PM, Room: 303, Chair: Anne Canuto

4:00PM *Face Recognition through a Chaotic Neural Network Model [#N-14268]*

Luis Fernando Martins Carlos Jr. and Joao Luis Rosa, Universidade de Sao Paulo, Brazil

K-sets models are connectionist methods based on neuron populations, conceived through EEG analyses of the mammalian olfactory system. These models present a biologically more plausible structure and behavior than other neural networks models. K-sets have been used in many machine-learning problems, with potential application on pattern recognition while presenting novel chaotic concepts for signal processing. This paper presents the characteristics of the K-sets models and their application in a face recognition task. Our method was tested using Yale Face Database B and the results show that it outperforms popular recognition methods.

4:20PM *Confidence Factor and Feature Selection for Semi-Supervised Multi-Label Classification Methods [#N-14313]*

Fillipe Rodrigues, Anne Canuto and Araken Santos, Federal Institute of RN, Brazil; Federal University of RN, Brazil; Federal Rural University of Semi-Arido, Brazil

In this paper, we investigate two important problems in multi-label classification algorithms, which are: the number of labeled instances and the high dimensionality of the labeled instances. In the literature, we can find several papers about multi-label classification problems, where an instance can be associated with more than one label simultaneously. One of the main issues with multi-label classification methods is that many of these require a high number of instances to be able to generalize in an efficient way. In order to solve this problem, we used semi-supervised learning, which combines labeled and unlabeled instances during the training process. In this sense, the semi- supervised learning may become an essential tool to define, efficiently, the process of automatic assignment of labels. Therefore, this paper presents four semi-supervised methods for the multi-label classification,

focusing on the use of a confidence parameter in the process of automatic assignment of labels. In order to validate the feasibility of these methods, an empirical analysis will be conducted using high-dimensional datasets, aiming to evaluate the performance of such methods in different situations. In this case, we will apply a feature selection algorithm in order to reduce, in an efficient way, the number of features to be used by the classification methods.

4:40PM *Applying the Self-Training Semi-Supervised Learning in Hierarchical Multi-Label Methods [#N-14314]*

Araken Santos and Anne Canuto, Federal Rural University of Semi-Arido, Brazil; Federal University of RN, Brazil

In classification problems with hierarchical structures of labels, the target function must assign several labels that are hierarchically organized. The hierarchical structures of labels can be used either for single-label (one label per instance) or multi-label classification problems (more than one label per instance). In general, classification tasks are usually trained using a standard supervised learning procedure. However, the majority of classification methods require a large number of training instances to be able to generalize the mapping function, making predictions with high accuracy. In order to smooth out this problem, the idea of semi-supervised learning has emerged. It combines labelled and unlabelled data during the training phase. Some semi- supervised methods have been proposed for single-label classification methods. However, very little effort has been done in the context of multi-label hierarchical classification. This paper proposes the use of a semi-supervised learning method for the multi-label hierarchical problems. In order to validate the feasibility of these methods, an empirical analysis will be conducted, comparing the proposed methods with their corresponding supervised versions. The main aim of this analysis is to observe whether the semi-supervised methods proposed in this paper have similar performance to the corresponding supervised versions.

5:00PM *Sampling-Based Learning Control for Quantum Discrimination and Ensemble Classification [#N-14354]*

Chunlin Chen, Daoyi Dong, Bo Qi, Ian Petersen and Herschel Rabitz, Nanjing University, China; University of New South Wales, Australia; Chinese Academy of Sciences, China; Princeton University, United States

Quantum ensemble classification has significant applications in discrimination of atoms (or molecules), separation of isotopic molecules and quantum information extraction. In this paper, we recast quantum ensemble classification as a supervised quantum learning problem. A systematic classification methodology is presented by using a sampling-based learning control (SLC) approach for quantum discrimination. The classification task is accomplished via simultaneously steering members belonging to different classes to their corresponding target states (e.g., mutually orthogonal states). Numerical results demonstrate the effectiveness of the proposed approach for the discrimination of two quantum systems and the binary classification of two- level quantum ensembles.

5:20PM *An Improved Extreme Learning Machine with Adaptive Growth of Hidden Nodes Based on Particle Swarm Optimization [#N-14530]*

Min-Ru Zhao, Jian-Ming Zhang and Fei Han, Jiangsu University, China

Extreme learning machines (ELMs) for generalized single-hidden-layer feedforward networks which perform well in both regression and classification applications have caused a lot of attention. To obtain compact network architecture with better generalization performance, an improved ELM with adaptive growth of hidden nodes (AG-ELM) combined with particle swarm optimization (PSO) is proposed in this study. PSO is used to select the optimal weights and biases to overcome the deficiency of the standard AG-ELM. All parameters in one network are represented by one particle in PSO, and the dimension of the particle increases in the training process. Simulation results on various test problems verify that the proposed algorithm achieves more compact network architecture and has better generalization performance with less steps than classical AG-ELM.

5:40PM *Structural Representation and Reasoning in a Hybrid Cognitive Architecture [#N-14811]*

John Licato, Ron Sun and Selmer Bringsjord, Rensselaer Polytechnic Institute, United States

Psychologically and neurobiologically plausible models of knowledge often must make a difficult choice between distributed and localist representation. Distributed representation can be flexible and hold up well to noisy data, but localist models allow for structured knowledge to be represented unambiguously and reasoned over in rigorous, transparent fashion. We present a way of representing knowledge within the hybrid cognitive architecture CLARION. Our system allows both structured knowledge and distributed knowledge to synergistically coexist while remaining within the limits defined by CLARION's dual-process framework. After showing how our system can allow more complex knowledge structures to arise, we describe algorithms that use such structures to model many types of reasoning, including: analogical reasoning, deductive reasoning, moral reasoning, and more. We place the structural knowledge afforded CLARION within a formal hierarchy of expressivity for such knowledge, and discuss implications of this work.

Tuesday, July 8, 1:30PM-3:30PM

Special Session: TuN1-1 International Workshop on Computational Energy Management in Smart Grids I

Tuesday, July 8, 1:30PM-3:30PM, Room: 308, Chair: Stefano Squartini and Derong Liu

1:30PM *Exploring the Performance of Non-Negative Multi-Way Factorization for Household Electrical Seasonal Consumption Disaggregation [#N-14694]*

Marisa Figueiredo, Bernardete Ribeiro and Ana de Almeida, University of Coimbra, Portugal; Universitary Institute of Lisbon, Portugal

The performance of household electrical seasonal consumption disaggregation is explored in this paper. Firstly, given a tensor composed by the data for the several devices in the house, non-negative tensor factorization is performed in order to extract the most relevant components. Secondly, the outcome is embedded in the test step, where only the whole-home measured consumption is available. Lastly, the disaggregated data by device is obtained by factorizing the associated matrix regarding the learned model. This source separation approach thus requires prior data, needed to learn the source models. Nevertheless, the consumer behaviors vary along time particularly from season to season, and hence also the electrical consumption. Consequently, the assessment of performance at long-term and across different times of the year is essential. We evaluate the performance of load disaggregation by this supervised method along several years and across seasons. Towards this end, computational experiments were yielded using real-world data from a household electrical consumption measurements along several years. The analysis of the computational results illustrates the adequacy of the method for handling the shifts between seasons.

1:50PM *Community Detection Based on Local Topological Information in Power Grid [#N-14172]*
Zengqiang Chen, Zheng Xie and Qing Zhang, Nankai University, China; Civil Aviation University of China, China

This paper proposes a novel algorithm based on local similarities to detect community structure in complex network. By analyzing the strengths and weaknesses of popular similarity indexes, a new index of node similarity is defined which can reflect closeness of local connections in networks as community does. And the similarity between a node and a community is defined by the sum of similarities between this node and all nodes within the community. Then networks can be partitioned without presetting the number of communities based on the assumption that nodes with highest similarities tend to merge together, additionally bridging nodes as byproducts. This method's effectiveness is confirmed by applying it to the IEEE 39-bus and 118-bus standard power grids. Influence of the bridging nodes in cascading failures is also discussed.

2:10PM *A Heuristic to Generate Initial Feasible Solutions for the Unit Commitment Problem [#N-14296]*
Yi Sun, Y.S. Albert Lam and O.K. Victor Li, The University of Hong Kong, Hong Kong; Hong Kong Baptst University, Hong Kong

This paper presents a heuristic approach to generate initial feasible solutions for the Unit Commitment (UC) problem in electric power generation. The Chemical Reaction Optimization (CRO) algorithm is implemented to solve this problem. Multiple generator constraints and system constraints are considered. We also program the binary PSO and the Elite PSO (EPSO) for comparison. The proposed heuristic approach is combined with the three optimization algorithms to form H- CRO, H-PSO and H-EPSO. We test the performance of all algorithms on the standard 10-unit system. Simulation results show that the heuristic can improve the performance and CRO provides better convergence than the two PSO algorithms. H-CRO is also tested on a 20-unit and 100-unit system to show its capability. The results provided in this paper suggest that the proposed heuristic approach is a better alternative for solving the UC problem. CRO also has its advantage in optimizing UC problems.

2:30PM *Computational Intelligence in Smart Water and Gas Grids: An Up-to-Date Overview [#N-14372]*
Marco Fagiani, Stefano Squartini, Leonardo Gabrielli, Mirco Pizzichini and Susanna Spinsante, Universita` Politecnica delle Marche, Italy

Computational Intelligence plays a relevant role in several Smart Grid applications, and there is a florid literature in this regard. However, most of the efforts have been oriented to the electrical energy field, for which many contributions have appeared so far, also facilitated by the availability of suitable databases to use for system training and testing. Different is the case for the water and gas scenarios: this work is thus oriented to present the state of the art techniques for these grids, from 2009 to date. In particular, the focus is on load forecasting and leakage detection applications, that are the most addressed in the literature and present the biggest interest from a commercial point of view as well: the main characteristics and registered performance for all the reviewed approaches are reported. Along this direction, an extensive search of used databases has been performed and thus made available to the research community.

2:50PM *Residential Energy System Control and Management Using A Hill-Climbing Heuristic Method [#N-14475]*
Luiz Carlos Roth, Eugenius Kaszkurewicz and Amit Bhaya, Universidade Federal do Rio de Janeiro, Brazil

This paper presents a Hill-climbing technique applied to a residential energy system control and management, based on battery energy storage connected to power grids. The main focus is to develop an optimal controller that is both easy to implement and capable of minimizing the electricity cost for residential customers. Simulation results corroborate the advantages of the proposed method.

Special Session: TuN1-2 Intelligent Vehicle Systems

Tuesday, July 8, 1:30PM-3:30PM, Room: 305A, Chair: Chaomin Luo and Yi Murphey

1:30PM *A Computationally Efficient Neural Dynamics Approach to Trajectory Planning of an Intelligent Vehicle [#N-14373]*
Chaomin Luo and Jiyong Gao, University of Detroit Mercy, United States

Real-time safety aware navigation of an intelligent vehicle is one of the major challenges in intelligent vehicle systems. Many studies have been focused on the obstacle avoidance to prevent an intelligent vehicle from approaching obstacles "too close" or "too far", but difficult to obtain an optimal trajectory. In this paper, a novel biologically inspired neural network methodology with safety consideration to realtime collision-free navigation of an intelligent vehicle with safety consideration in a non-stationary environment is proposed. The real-time vehicle trajectory is planned through the varying neural activity landscape, which represents the dynamic environment, in conjunction of a safety aware navigation algorithm. The proposed model for intelligent vehicle trajectory planning with safety consideration is capable of planning a real-time "comfortable" trajectory by overcoming the either "too close" or "too far" shortcoming. Simulation results are presented to demonstrate the effectiveness and efficiency of the proposed methodology that performs safer collision-free navigation of an intelligent vehicle.

1:50PM *Decision Tree Assisted EKF for Vehicle Slip Angle Estimation Using Inertial Motion Sensors [#N-14401]*
James Coyte, Boyuan Li, Haiping Du, Weihua Li, David Stirling and Montserrat Ros, University of Wollongong, Australia

Vehicle side slip angle is a critical variable used in car safety systems like Electronic Stability Control. Due to the practical difficulty in direct measurement of side slip angle, accurate estimation of vehicle side slip angle using available signals is becoming important. This paper presents a novel algorithm for estimating the side slip angle of a vehicle in real time using inertial motion sensors. The algorithm uses a J48 decision tree classifier to assist the Extended Kalman Filter (EKF) predictions of the vehicle side slip angle. The decision tree classifies the inertial data into classes based on the condition the slip angle is expected to be in. Using the class information asserted by the classifier, the error covariance parameter of the EKF is adjusted to compensate for changes in disturbances and nonlinearities. The results show that the decision tree assisted EKF technique presented in this paper is capable of predicting the slip angle with sound accuracy using inertial motion data.

2:10PM *Traffic Sign Recognition Using a Novel Permutation-Based Local Image Feature [#N-14405]*

Tian Tian, Ishwar Sethi and Patel Nilesh, Huazhong Univ. of Sci. and Tech., China; Oakland Unviersity, United States

Traffic sign recognition (TSR) is an essential research issue in the design of driving support system and smart vehicles. In this paper, we propose a permutation-based image feature to describe traffic signs, which has an inherent advantage of illumination invariance and fast implementation. Our proposed feature LIPID (local image permutation interval descriptor) employs interval division and zone number assignment on order permutation of pixel intensities, and takes the zone numbers as the descriptor. A comprehensive performance evaluation on German Traffic Sign Recognition Benchmark (GTSRB) dataset is carried out, which reveals the great performance of our proposed method. Experiment results exhibit that our feature outperforms some state-of-the-art descriptors, showing a potential prospect in TSR applications.

2:30PM *Specific Humidity Forecasting Using Recurrent Neural Network [#N-14647]*

Chen Fang, Xipeng Wang and Yi Murphey, Univ. of Michigan-Dearborn, United States

This paper presents our research in building a virtual humidity sensor using recurrent Neural Networks. Recurrent Neural Networks are promising methods for the prediction of time series because provide feedback connections from hidden layer to its inputs and, therefore, can store temporal information learned from previous time steps. This study applies Elman Recurrent Neural Network (ERNN) to forecast the specific humidity from three weather stations. In addition, this study examines the feasibility of applying ERNN in time series forecasting by comparing it with multilayer perceptron network. The experiment results indicate that ERNN is a promising alternative to specific humidity forecasting.

2:50PM *A Computationally Efficient Complete Area Coverage Algorithm for Intelligent Mobile Robot Navigation [#N-14770]*

Eene Eu Jan, Shao-Ting Shih, Lun-Ping Hung and Chaomin Luo, National Taipei University, Taiwan; University of Detroit Mercy, United States

Complete area coverage navigation (CAC) requires a special type of robot path planning, where the robots should visit every point of the state workspace. CAC is an essential issue for cleaning robots and many other robotic applications. Real-time complete area coverage path planning is desirable for efficient performance in many applications. In this paper, a novel vertical cell-decomposition (VCD) with convex hull (VCD-CH) approach is proposed for real-time CAC navigation of autonomous mobile robots. In this model, a vertical cell-decomposition (VCD) methodology and a spanning-tree based approach with convex hull are effectively integrated to plan a complete area coverage motion for autonomous mobile robot navigation. The computational complexity of this method with minimum trajectory length planned by a cleaning robot in the complete area coverage navigation with rectangle obstacles in the Euclidean space is O(n log n). The performance analysis, computational validation and comparison studies demonstrate that the proposal model is computational efficient, complete and robust.

3:10PM *Intelligent Trip Modeling on Ramps Using Ramp Classification and Knowledge Base [#N-14944]*

Xipeng Wang, Jungme Park, Yi Murphey, Johannes Kristinsson, Ming Kuang and Tony Phillips, University of Michigan-Dearborn, United States; Ford Motor Company, United States

Speed profile prediction on ramps is a challenging problem because speed changes on ramps involve complicated lane maneuvering and frequent acceleration or deceleration depending on geometry of the ramp and traffic volumes. Ramps can be categorized into three groups based on their interconnection of freeway: freeway entering ramps, freeway exit ramps, and inter freeway ramps. However, different geographical shapes of ramps within the same category cause different speed profile distributions. To predict speed profile on any ramp types, we proposed an Intelligent Trip Modeling on Ramp (ITMR) System that consists of a ramp classification method based on the decision tree and speed profile prediction neural networks. The proposed ITMR takes inputs from geographical data on the route and also the personal driving pattern extracted from the knowledge base built with the individual historical driving data. Experimental results show that the proposed system learned dynamic ramp speed changes very well to provide accurate prediction results on multiple freeway entering ramps, exit ramps and inter freeway ramps.

Special Session: TuN1-3 Biologically Inspired Computational Vision

Tuesday, July 8, 1:30PM-3:30PM, Room: 305B, Chair: Khan Iftekharuddin

1:30PM *Plant Recognition Based on Intersecting Cortical Model [#N-14452]*

Zhaobin Wang, Xiaoguang Sun, Yaonan Zhang, Yide Ma, Hongjuan Zhang, Yurun Ma and Weiying Xie, Lanzhou University, China; Cold and Arid Regions Environmental and Enineering Research Institute, China

plant recognition recently becomes more and more attractive in computer vision and pattern recognition. Although some researchers have proposed several methods, their accuracy is not satisfactory. Therefore, a novel method of plant recognition based on leaf image is proposed in the paper. Both shape and texture features are employed in the proposed method. Texture feature is extracted by intersecting cortical model, and shape feature is obtained by the representation of center distance sequence. Support vector machine is employed for the classifier. The leaf image is preprocessed to get better quality for extracting features, and then entropy sequence and center distance sequence are obtained by intersecting cortical model and center distance transform, respectively. Redundant data of entropy sequence vector and center distance are reduced by principal component analysis. Finally, feature vector is imported into the classifier for classification. In order to evaluate the performance, several existing methods are used to compare with the proposed method and three leaf image datasets are takes as test samples. The experimental result shows the proposed method gets the better accuracy of recognition than other methods.

1:50PM *Image Factorization and Feature Fusion for Enhancing Robot Vision in Human Face Recognition [#N-14482]*

Hui Yu, University of Portsmouth, United Kingdom

Illumination variation has been a challenging problem for face recognition in robot vision. To reduce the effect caused by illumination variation, a lot of studies have been explored. The Total Variation (TV) method is particular used to factorize images into a low frequency component and a high frequency one. However, the low frequency component still contains significant intrinsic features resulting in failure in face recognition in some cases. In this paper, we propose to further extract illumination invariant

features from face images under uncontrolled varying lighting conditions. The Nonsampled Contourlet Transform (NSCT) method is employed to enhance the extraction of intrinsic feature. The combined factorization model is very effective in the experiment on the Yale database.

2:10PM *Linear Regression for Head Pose Analysis [#N-14484]*

Hui Yu and Honghai Liu, University of Portsmouth, United Kingdom

Extensive research has been conducted to estimate and analyze head poses for various applications. Most existing methods tend to detect facial features and locate landmarks on a face for pose estimation. However, the sensitivity to occlusion of some face parts with key features and uncontrolled illumination of face images make the facial feature detection vulnerable. In this paper, we propose a framework for pose estimation without the need of face features or landmarks detection. Specifically, we formulate the pose estimation as a linear regression applied to the pose space. This method is based on the assumption that pose space cannot be linearly approximated in the pose subspace. The experimental results strongly support this assumption. In cases where the database does not obtain various poses in the intraclass, we propose to generate those poses through a 3D reconstruction and projection method. The experiment conducted on the CMU MultiPIE and IMM Face database has shown the effectiveness of the proposed method.

2:30PM *Improved Training of Cellular SRN Using Unscented Kalman Filtering for ADP [#N-14741]*

Lasitha Vidyaratne, Mahbubul Alam, John Anderson and Khan Iftekharuddin, Old Dominion University, United States; University of Memphis, United States

Cellular Simultaneous Recurrent Network (CSRN) is a unique type of recurrent networks that is designed to solve complex optimization problems. This network has already shown to successfully solve many challenging problems such as 2D maze navigation, image registration and affine transformation, game of go, and power system voltage profile prediction. One of the main challenges of using a complex network structure as CSRN is to efficiently train the network. Many representative training algorithms such as Back-propagation Through Time (BPTT), Extended Kalman Filtering (EKF) and Particle Swarm Optimization (PSO) have been used to train CSRN. Our prior works with CSRN suggest that for large number of network inputs, which is very common for large scale maze and image data, computational complexity of computing Jacobian in EKF training becomes prohibitive. In this paper, we propose Unscented Kalman Filter (UKF) for the training of CSRN to avoid computing Jacobian. We show that CSRN trained with UKF can solve the 2D maze traversal problem with better convergence rate than that of EKF. We also report preliminary results on binary image affine transformation wherein CSRN trained with UKF offers comparable performance to that of EKF. A comparison has been obtained between CSRN with GMLP core versus an Elman core trained with UKF for Affine transform results. Finally, we show that for more complex applications such as large scale image processing, UKF is much faster than EKF in training CSRN.

2:50PM *Retinal Blood Vessel Segmentation Using Bee Colony Optimisation and Pattern Search [#N-14759]*

Eid Emary, Hossam Zawbaa, Aboul Ella Hassanien, Gerald Schaefer and Ahmad Taher Azar, Cairo University, Egypt; BeniSuef University, Egypt; Loughborough University, United Kingdom; Benha University, Egypt

Accurate segmentation of retinal blood vessels is an important task in computer aided diagnosis of retinopathy. In this paper, we propose an automated retinal blood vessel segmentation approach based on artificial bee colony optimisation in conjunction with fuzzy c-means clustering. Artificial bee colony optimisation is applied as a global search method to find cluster centers of the fuzzy c-means objective function. Vessels with small diameters appear distorted and hence cannot be correctly segmented at the first segmentation level due to confusion with nearby pixels. We employ a pattern search approach to optimisation in order to localise small vessels with a different fitness function. The proposed algorithm is tested on the publicly available DRIVE and STARE retinal image databases and confirmed to deliver performance that is comparable with state-of-the-art techniques in terms of accuracy, sensitivity and specificity.

3:10PM *Shoreline Extraction from the Fusion of LiDAR DEM Data and Aerial Images Using Mutual Information and Genetic Algrithms [#N-14771]*

Amr Yousef and Khan Iftekharuddin, Alexandria University, Egypt; Old Dominion University, United States

As sea level rises and coastal populations continue to grow, there is an increased demand for understanding the accurate position of the shorelines. The automatic extraction of shorelines utilizing the digital elevation models (DEMs) obtained from light detection and ranging (LiDAR), aerial images and multi-spectral images has become very promising. In this paper, we propose a new algorithm that can effectively extract shorelines from fused lidar DEMs with aerial images depending on the availability of training data. The LiDAR data and the aerial image are fused together by maximizing the mutual information using the genetic algorithm. The extraction of shoreline is obtained by segmenting the fused data into water and land by means of the support vector machines classifier. Compared with other relevant techniques in literature, the proposed method offers better accuracy in shoreline extraction.

TuN1-4 Real World Applications II

Tuesday, July 8, 1:30PM-3:30PM, Room: 305C, Chair: Lipo Wang

1:30PM *A Novel Fuzzy Multi-Objective Framework to Construct Optimal Prediction Intervals for Wind Power Forecast [#N-14152]*

Abdollah Kavousi-Fard, Abbas Khosravi and Saeid Nahavandi, Shiraz University of Technology, Iran; Deakin University, Australia

Accurate forecasting of wind power is a challenging issue in the power engineering area. This paper proposes a new multi-objective framework based on fuzzy logic systems to construct optimal prediction intervals (PIs) for wind power generation. In order to model the stochastic and nonlinear behavior of the wind power samples, the idea of lower upper bound estimation (LUBE) method is used here. The proposed method simultaneously satisfies the requirements for PI coverage probability (PICP) and PI normalized average width (PINAW). An improved version of particle swam optimization (PSO) is applied here to train models and construct PIs. Data sets of a real wind farm in Australia is used as the case study to examine performance of the proposed method. Simulation results indicate the excellent capability of the proposed method in generating reliable and informative PIs in a short time.

1:50PM *AORS: Affinity-Based Outlier Ranking Score [#N-14299]*

Shaohong Zhang, Hau-San Wong, Wen-Jun Shen and Dongqing Xie, Guangzhou University, China; City University of Hong Kong, Hong Kong

Outlier ranking methods can provide a quantitative measure to evaluate the outlierness of data instances in data clustering and attract great interest in pattern recognition and data mining communities. However, it has been pointed out that the diverse scaling ranges of these scores bring difficulty to result interpretation. Moreover, popular outlier ranking scores based on simple distance measures might not accurately reflect the complex affinity among data points. In this paper, we propose a new outlier ranking method based on consensus affinity of a cluster ensemble. Two new outlier ranking scores generalized from well-known clustering evaluation measures, Rvv from the RAND measure and ARIvv from Adjusted Rand Index (ARI), are adopted for outlierness evaluation. Compared to other outlierness ranking measures, the two new measures have the desired bounds without additional transformations. Consistent with the improvement of Adjusted Rand Index (ARI) over RAND, we find that ARIvv also significantly outperforms Rvv. Benefiting from the consensus affinity of a cluster ensemble, our proposed method with the ARIvv score provide significant improvement beyond a number of competing algorithms on public UCI benchmark data sets. Studies with both theoretical analysis and experimental validation show the effectiveness of our proposed methods.

2:10PM *Applications of Probabilistic Model Based on JoyStick Probability Selector [#N-14357]*

Marko Jankovic and Nikola Georgijevic, EE Institute "Nikola Tesla", Serbia and Montenegro

Recently, it has been shown that a probabilistic model based on two of the main concepts in quantum physics - a density matrix and the Born rule, can be suitable for the modeling of learning algorithms in biologically plausible artificial neural networks framework. It has been shown that the proposed probabilistic interpretation is suitable for modeling on-line learning algorithms for Independent /Principal/Minor Component Analysis, which could be realized on parallel hardware based on very simple computational units. Also, it has been shown that the quantum entropy of the system, related to that model, can be successfully used in the problems like change point detection. Here, it will be shown that the proposed model can be successfully used in other areas of applied signal processing, with some examples of applications in the area of power electronics and general classification problems.

2:30PM *An Intelligent Analysis and Prediction Model for On-Demand Cloud Computing Systems [#N-14787]*

Xiuju Fu, Xiaorong Li, Yongqing Zhu, Lipo Wang and Siow mong, Rick Goh, Institute of high performance computing, Singapore; Data storage institute, Singapore; Nanyang Technological University, Singapore

In this paper, an intelligent model for analyzing and predicting cloud computing resource utilization is proposed to enhance on-demand services in cloud computing systems. The model is with the capability to discover active users and mine the system storage utilization patterns. This model is also with learning capabilities to adapt the dynamics in the cloud computing platform by capturing changing patterns of system storage utilization, and it employs data mining means for computing the practical model to be used for prediction and providing inputs for intelligent management in the on-demand cloud computing system. We have evaluated the proposed analysis and prediction model in a cloud computing platform. High prediction accuracies of 95% and 86% have been achieved in 1-day ahead and 7-day ahead system utilization prediction, respectively.

2:50PM *Learning Using Privileged Information (LUPI) for Modeling Survival Data [#N-14244]*

Han-Tai Shiao and Vladimir Cherkassky, University of Minnesota, United States

Survival data is common in medical applications. The challenge in applying predictive data-analytic methods to survival data is in the treatment of censored observations, since the survival times for these observations are unknown. This paper presents formalization of the analysis of survival data as a binary classification problem. For this binary classification setting, we propose a strategy for encoding censored data, leading to the SVM+/LUPI formulations. Further, we present empirical comparison of the new method and the classical Cox modeling approach for predictive modeling of survival data. These comparisons suggest that for data sets with large amount of censored data, the proposed method consistently yields better predictive performance than classical statistical modeling.

3:10PM *A Google Approach for Computational Intelligence in Big Data [#N-14164]*

Andreas Antoniades and Clive Cheong Took, University of Surrey, United Kingdom

With the emerging field of big data, it is becoming increasingly important to equip machine learning algorithms to cope with volume, variety, and velocity of data. In this work, we employ the MapReduce paradigm to address these issues as an enabling technology for the well-known support vector machine to perform distributed classification of skin segmentation. An open source implementation of MapReduce called Hadoop offers a streaming facility, which allows us to focus on the computational intelligence problem at hand, instead of focusing on the implementation of the learning algorithm. This is the first time that support vector machine has been proposed to operate in a distributed fashion as it is, circumventing the need for long and tedious mathematical derivations. This highlights the main advantages of MapReduce - its generality and distributed computation for machine learning with minimum effort. Simulation results demonstrate the efficacy of MapReduce when distributed classification is performed even when only two machines are involved, and we highlight some of the intricacies of MapReduce in the context of big data.

TuN1-5 Feedforward Neural Networks II

Tuesday, July 8, 1:30PM-3:30PM, Room: 305D, Chair: Brijesh Verma

1:30PM *Explicit Feature Mapping via Multi-Layer Perceptron and Its Application to Mine-Like Objects Detection [#N-14143]*

Hang Shao and Nathalie Japkowicz, University of Ottawa, Canada

In this paper, a novel learning method is introduced that borrows simultaneously from the principles of kernel methods and multi-layer perceptron. Specifically, the method implements the feature mapping idea of kernel methods into a multi- layer perceptron. Unlike in kernel learning where the feature space is usually invisible and inaccessible, the multi-layer perceptron based mapping is explicit. Therefore, the proposed model can be learned directly in feature space. Together with the inherent sparse representation, the proposed approach will thus be much faster and easier to train even in the event of a large network size. The proposed approach is applied in the context of an Autonomous Underwater Vehicle Mine-Like Objects detection task. The results show that the proposed approach is able to improve upon the generalization performance of neural network based methods. Its prediction results are also close to or better than those obtained by kernel machines. Its learning and classification speed is shown to far surpass those of kernel machines. These results are confirmed on a number of experiments involving benchmarking UCI domains.

1:50PM *Compressing VG-RAM WNN Memory for Lightweight Applications [#N-14312]*

Edilson de Aguiar, Avelino Forechi, Lucas de Paula Veronese, Mariella Berger, Alberto F. De Souza, Claudine Badue and Oliveira-Santos Thiago, Universidade Federal do Espirito Santo, Brazil

The Virtual Generalizing Random Access Memory Weightless Neural Network (VG-RAM WNN) is an effective machine learning technique that offers simple implementation and fast training. One disadvantage of VG-RAM WNN, however, is the test time for applications with many training samples, i.e. large multi-class classification applications. In such cases, the test time tends to be high, since it increases with the size of the memory of each neuron. In this paper, we present a new methodology for handling such applications using VG- RAM WNN. By employing data clustering techniques to reduce the overall size of the neurons' memory, we were able to reduce the network's memory footprint and the system's runtime, while maintaining a high and acceptable classification performance. We evaluated the performance of our VG-RAM WNN system with compressed memory on the problem of traffic sign recognition. Our experimental results showed that, after compression, the system was able to run at very fast response times in standard computers. Also, we were able to load and run the system at interactive rates in small low-power systems, experiencing only a small reduction in classification performance.

2:10PM *Data Driven Modeling for UGI Gasification Process via a Variable Structure Genetic BP Neural Network [#N-14445]*

Shida Liu, Zhongsheng Hou and Chenkun Yin, Beijing Jiaotong University, China

An enhanced genetic BP neural network with link switches (EGA-BPNN-LS) is proposed in this work to address data-driven modeling problem for gasification processes inside a UGI gasifier. During gasification processes, the online measured gasification zone's temperature, which is a key index, is difficult to model its' dynamics via the first principle because of the tremendous complexity of the gasification process, which is mainly reflected from severe changes of the gas temperature versus infrequent and small manipulations of parts of the input variables. EGA-BPNN-LS, which incorporates a neural networks with link switches (NN-LS) with an enhanced genetic algorithm (EGA) and the Levenberg-Marquardt (LM) algorithm, can not only learn the relationships between control inputs and system outputs from historical data with the help of optimized network's structure through combination of EGA and NN-LS, but also overcome the drawbacks of gradient-based method and make full use of the network's gradient information to achieve a satisfactory accuracy. A set of data collected from the practical fields are applied to modeling via EGA-BPNN- LS, by which the efficiency of EGA-BPNN-LS is verified.

2:30PM *MofN Rule Extraction from Neural Networks Trained with Augmented Discretized Input [#N-14505]*

Rudy Setiono, Arnulfo Azcarraga and Yoichi Hayashi, National University of Singapore, Singapore; De La Salle University, Philippines; Meiji Univerisity, Japan

The accuracy of neural networks can be improved when they are trained with discretized continuous attributes as additional inputs. Such input augmentation makes it easier for the network weights to form more accurate decision boundaries when the data samples of different classes in the data set are contained in distinct hyper-rectangular subregions in the original input space. In this paper we present first how a neural network can be trained with augmented discretized inputs. The additional inputs are obtained by simply dividing the original interval of each continuous attribute into subintervals of equal length. Thermometer encoding scheme is used to represent these discretized inputs. The network is then pruned to remove most of the discretized inputs as well as the original continuous attributes as long as the network still achieves a minimum preset accuracy requirement. We then discuss how MofN rules can be extracted from the pruned network by analyzing the activations of the network's hidden units and the weights of the network connections that remain in the pruned network. For data sets that have sample classes defined by relatively complex boundaries, surprisingly simple MofN rules with very good accuracy rates are obtained.

2:50PM *Optimizing Configuration of Neural Ensemble Network for Breast Cancer Diagnosis [#N-14523]*

Peter McLeod and Brijesh Verma, Central Queensland University, Australia

Determining the best values for the parameters of a classifier is a challenge. This challenge is compounded for ensembles. This research evaluates the number of neurons for candidate networks and the number of committee members in our work on variable neural classifiers for breast cancer diagnosis. The evaluation reveals that good neural network accuracy can be achieved with a small number of neurons in the hidden layer and three committee members in the ensemble. The proposed methodology is tested on two benchmark databases achieving 99% classification accuracy.

3:10PM *An Efficient Conjugate Gradient Based Multiple Optimal Learning Factors Algorithm of Multilayer Perceptron Neural Network [#N-14829]*

Xun Cai, Kanishka Tyagi and Michael T Manry, Shandong University, China; The University of Texas at Arlington, United States

In this paper, a second order learning algorithm based on Conjugate Gradient (CG) method for finding Multiple Optimal Learning Factors (MOLFs) of multilayer perceptron neural network is proposed in details. The experimental results on several benchmarks show that, compared with One Optimal Learning Factor algorithm with Optimal Output Weights (1OLF-OWO) and Levenberg-Marquardt learning algorithm (LM), our proposed CG based MOLF method with optimal output weights which is also called MOLFCG-OWO algorithm has not only significantly faster convergence rate than that of 1OLF and even super to that of LM learning algorithm for some datasets with much less computational time, but also more generalization capability than 1OLF-OWO. Thus, MOLFCG-OWO algorithm is suggested better choice for some practical applications.

TuN1-6 Supervised Learning I

Tuesday, July 8, 1:30PM-3:30PM, Room: 305E, Chair: Jose Principe

1:30PM *Imputation of Missing Data Supported by Complete p-Partite Attribute-Based Decision Graphs [#N-14358]*

Joao Bertini, Maria Nicoletti and Liang Zhao, Universidade de Sao Paulo, Brazil; Universidade Federal de Sergipe, Brazil

Missing attribute values is a recurrent problem in data mining and machine learning. Although there are plenty of techniques to handle this problem, most of them are too simplistic to provide a good estimation for absent attribute values. A very active research area focuses on solving the missing attribute value problem via imputation methods, which replaces missing data with substituted values. This paper proposes a new imputation method which uses a special graph named Complete p-Partite Attribute-based Decision Graphs (CpP-AbDG) to estimate, in a consistent and plausible way, the missing values. The graph is built by considering the range of each attribute that describes the data divided into subintervals; sub-intervals are approached as the vertices of a graph. Edges are then established between pairs of different vertices, provided they do not related to the same attribute. The edges and vertices are finally assigned a weight, based on distributions of the classes. The resulting CpP-AbDG has shown to be a suitable and informative data structure for finding the proper interval in which a missing attribute value should lie, taking into account all the attributes that describe the data. Results comparing the proposed approach to classical ones in an computational environment that considers classification problems as an evaluation criteria, show the potential of the method.

1:50PM *An Asymmetric Stagewise Least Square Loss Function for Imbalanced Classification [#N-14375]*

Guibiao Xu, Bao-Gang Hu and Jose Principe, Institute of Automation, Chinese Academy of Sciences, China; University of Florida, United States

In this paper, we present an asymmetric stagewise least square (ASLS) loss function for imbalanced classification. While keeping all the advantages of the stagewise least square (SLS) loss function, such as, better robustness, computational efficiency and sparseness, the ASLS loss extends the SLS

loss by adding another two parameters, namely, ramp coefficient and margin coefficient. Therefore, asymmetric ramps and margins can be formed which makes the ASLS loss be more flexible and appropriate for processing class imbalance problems. A reduced kernel classifier of the ASLS loss is also developed which only uses a small part of the dataset to generate an efficient nonlinear classifier. Experimental results confirm the effectiveness of the ASLS loss in imbalanced classification.

2:10PM *An Analysis Based on F-Discrepancy for Sampling in Regression Tree Learning [#N-14467]*
Cristiano Cervellera, Mauro Gaggero and Danilo Maccio, Institute of Intelligent Systems for Automation, National Research Council, Italy

When the problem of learning from data is solved through a regression tree estimator, the quality of the available observations is an important issue, since it influences directly the accuracy of the resulting model. It becomes particularly relevant when there is freedom to sample the input space arbitrarily to build the tree model or, alternatively, when we need to select a subsample to train the tree estimator on a computationally feasible input set, or to evaluate the goodness of the estimation on a test set. Here the accuracy of estimation based on regression trees is analyzed from the point of view of geometric properties of the available input data. In particular, the concept of F- discrepancy, a quantity that measures how well a set of points represents the distribution underlying the input generation process, is applied to derive conditions for convergence to the optimal piecewise-constant estimator for the unknown function we want to learn. The analysis has a constructive nature, allowing to select in practice good input sets for the problem at hand, as shown in a simulation example involving a real data set.

2:30PM *Coupled Fuzzy k-Nearest Neighbors Classification of Imbalanced Non-IID Categorical Data [#N-14633]*
Chunming Liu, Longbing Cao and Philip S Yu, University of Sydney Technology, Australia; University of Illinois at Chicago, United States

Mining imbalanced data has recently received increasing attention due to its challenge and wide applications in the real world. Most of the existing work focuses on numerical data by manipulating the data structure which essentially changes the data characteristics or developing new distance or similarity measures which are designed for data with the so-called IID assumption, namely data is independent and identically distributed. This is not consistent with the real life data and business needs, which request to fully respect the data structure and coupling relationships embedded in data objects, features and feature values. In this paper, we propose a novel coupled fuzzy similarity-based classification approach to cater for the difference between classes by a fuzzy membership and the couplings by coupled object similarity, and incorporate them into the most popular classifier: kNN to form a coupled fuzzy kNN (ie. CF-kNN). We test the approach on 14 categorical data sets compared to several kNN variants and classic classifiers including C4.5 and NaiveBayes. The experimental results show that CF-kNN outperforms the baselines, and those classifiers incorporated with the proposed coupled fuzzy similarity perform better than their original editions.

2:50PM *Wind Power Forecasting- An Application of Machine Learning in Renewable Energy [#N-14630]*
Jawad Ali, Gul Muhammad Khan and Sahibzada Ali Mahmud, University of Engineering and Technology, Peshawar, Pakistan

The advancement in renewable energy sector being the focus of research these days, a novel neuro evolutionary technique is proposed for modeling wind power forecasters. The paper uses the robust technique of Cartesian Genetic Programming to evolve ANN for development of forecasting models. These Models predicts power generation of a wind based power plant from a single hour up to a year - taking a big lead over other proposed models by reducing its MAPE to as low as 1.049% for a single day hourly prediction. Results when compared with other models in the literature demonstrated that the proposed models are among the best estimators of wind based power generation plants proposed to date.

3:10PM *Signature Identification via Efficient Feature Selection and GPU-Based SVM Classifier [#N-14712]*
Bernardete Ribeiro, Noel Lopes and Joao Goncalves, University of Coimbra, Portugal; Polytechnic of Guarda, Portugal

The problem of handwritten signature recognition is considered significant in biometrics, in particular for determining the validity of official documents. The rationale consists of creating an off-line classifier to discriminate between fake (forged) and genuine digitalized signatures. In such applications containing thousands of samples machine learning techniques such as Support Vector Machines (SVM) play a preponderant role in overcoming the challenges inherent to this problematic. However, to deal with the computational burden of calculating the large Gram matrix, approaches such as Graphics Processing Units (GPU) computing are required for efficiently processing big image biometric data. In this paper, first, we present an empirical study for efficient feature selection concerning the signature identification problem. Second, an GPU-based SVM classifier that integrates a component of the open source Machine Learning Library (GPUMLib) supporting several kernels is developed. Third, we ran several experiments with improved performance over baseline approaches. From our study, we gain insights in both performance and computational cost under a number of experimental conditions, and conclude that the most appropriate model is usually a trade-off between performance and computational cost for a given experimental setup and dataset.

Tuesday, July 8, 3:30PM-6:00PM

Poster Session: PN2 Poster Session 2

Tuesday, July 8, 3:30PM-6:00PM, Room: Posters Area (Level 3), Chair: Danil Prokhorov

P301 *Hopfield Neural Network for Seismic Velocity Picking [#N-14237]*
Kou-Yuan Huang and Jia-Rong Yang, National Chiao Tung University, Taiwan

The Hopfield neural network (HNN) is adopted for velocity picking in the time-velocity semblance image of seismic data. A Lyapunov function in the HNN is set up from the velocity picking problem. We use the gradient descent method to decrease the Lyapunov function and derive the equation of motion. According to the equation of motion, each neuron is updated until no change. The converged network state represents the best polyline in velocity picking. We have experiments on simulated and real seismic data. The picking results are good and close to the human picking results.

P302 *Deep Neural Networks for Mandarin Tone Recognition [#N-14241]*
Mingming Chen, Zhanlei Yang and WenJu Liu, National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of Sciences, China

This paper investigates the application of deep models including deep maxout networks(DMNs) to Mandarin tone recognition. Our focus is on the capacity of extracting high-level robust features and fusing different kinds of

serially- concatenated features of deep models. Furthermore, Maxout networks have been proposed to integrate dropout naturally and achieve state-of-the-art results. Therefore, we investigate the advantage of DMNs when the training data is limited and imbalanced. Our experiments on the ASCCD corpus show that comparing with shallow models such as one-hidden layer multi-perception (MLP) and support vector machine(SVM), deep models improve Mandarin tone recognition significantly. Among the deep models, DMNs can get better performance comparing with other deep neural networks based on sigmoid units or rectified linear units(ReLU).

P303 *An Adaptive Multiclass Boosting Algorithm for Classification [#N-14262]*

Shixun Wang, Peng Pan and Yansheng Lu, Huazhong University of Science and Technology, China

A large number of practical domains, such as scene classification and object recognition, have involved more than two classes. Therefore, how to directly conduct multiclass classification is being an important problem. Although some multiclass boosting methods have been proposed to deal with the problem, the combinations of weak learners are confined to linear operation, namely weighted sum. In this paper, we present a novel large-margin loss function to directly design multiclass classifier. The resulting risk, which guarantees Bayes consistency and global optimization, is minimized by gradient descent or Newton method in a multidimensional functional space. At every iteration, the proposed boosting algorithm adds the best weak learner to the current ensemble according to the corresponding operation that can be sum or Hadamard product. This process grown in an adaptive manner can create the sum of Hadamard products of weak learners, leading to a sophisticated nonlinear combination. Extensive experiments on a number of UCI datasets show that the performance of our method consistently outperforms those of previous multiclass boosting approaches for classification.

P304 *Animal Group Behavioral Model with Evasion Mechanism [#N-14287]*

Zhiping Duan and Xiaodong Gu, Department of Electronic Engineering, Fudan University., China

Modeling behavioral mechanism of animal group promotes the development of group animation and other fields involving crowd simulation. This paper introduces a model to mimic behaviors of animal group. We proposes a swarming intelligence algorithm, Evasion Mechanism Artificial Fish School Algorithm (EM-AFSA) in our model, in which AFSA often focuses on optimization. The EM-AFSA introduces a new mechanism, i.e. evasion, which enables the group to avoid obstacles and collisions and to evade predation. It also includes flocking, foraging and tailgating. It is convenient to show the dynamic demonstration of our model and the model vividly mimics the real animal group behavior, which could potentially be used in designing group animation.

P305 *Superpixel Appearance and Motion Descriptors for Action Recognition [#N-14329]*

Xuan Dong, Ah-Chung Tsoi and Sio-Long Lo, Macau University of Science and Technology, Macau

This paper introduces a novel video representation based on superpixel segmentation and appearance and motion descriptors. Superpixel represents a very useful preprocessing step for a wide range of computer vision applications, as they group pixels into perceptually meaningful atomic regions which can be used for recognizing complex motion patterns. We construct a novel video representation in terms of superpixel-based histograms of oriented gradients (HOG), histograms of optical flow (HOF) and motion boundary histograms (MBH) descriptors, and integrate such representations with a bag-of-features (BoF) model for classification. The proposed approach is evaluated in the context of action classification on a challenging benchmark dataset: UCF Sports dataset and it achieves 87.9% generalization accuracy. The experimental results demonstrate the advantage of superpixel-based descriptors compared to other approaches for human action recognition.

P306 *Structured Sparse Coding Method for Infrared Small Target Detection in Video Sequence [#N-14340]*

Chunwei Yang, Huaping Liu, Shouyi Liao and Shicheng Wang, Tsinghua University, China

In this paper, the infrared small target detection in video sequence is investigated. A collaborative structured sparse coding model which incorporates the L1,2 and L2,1 regularization terms is proposed to detect the infrared small target in video sequence. Further, online dictionary learning is embedded into the model and temporal information is incorporated to eliminate the clutters and noises. Finally, 4 simulation datasets are constructed to test the proposed method and the experimental validation shows promising results.

P307 *Human Activity Recognition Using Smart Phone Embedded Sensors: A Linear Dynamical Systems Method [#N-14345]*

Wen Wang, Huaping Liu, Lianzhi Yu and Fuchun Sun, Tsinghua University, China

This paper presents a novel framework of human activity recognition with time series collected from inertial sensors. We model each action sequence with a collection of Linear Dynamic Systems (LDSs), each LDS describing a small patch of the sequence. A codebook is formed by using the K-Medoid and a Bag-of-Systems (BoS) is developed to represent the time series. A great advantage of this method is that the complicated feature design procedure is avoided and the LDSs can well capture the dynamics of the time series. Our experiment validation on public dataset shows the promising results.

P308 *Effect of Spectrum Occupancy on the Performance of a Real Valued Neural Network Based Energy Detector [#N-14347]*

Adeiza James Onumanyi, Elizabeth Onwuka, Abiodun Musa Aibinu, Okechukwu Ugweje and Momoh Jimoh Salami, Federal University of Technology, Nigeria; The University of Akron, United States; International Islamic University Malaysia, Malaysia

In this paper, a newly proposed Real Valued Neural Network (RVNN) based Energy Detector (ED) is presented for Cognitive Radio (CR) application. With little available on the performance of EDs in varying spectrum occupancy conditions, we provide a study to understand how occupancy variation affects the performance of a newly proposed RVNN based ED and other ED schemes. Other factors such as varying Signal to Noise Ratio (SNR) and model order values were also examined in this study and result analysis conducted using the Precision-detection statistics. Implication of results obtained indicate that the RVNN based ED would perform optimum in high occupancy and SNR conditions for a model order choice of P = 20 . We also observed that the RVNN based ED would provide better precision performance characteristics over the Periodogram, Welch and Multitaper based ED schemes compared herein. Hence, the RVNN based ED suffices as a favourable choice for CR application even under varying occupancy conditions.

P309 *Scale Invariant Feature Transform Flow Trajectory Approach with Applications to Human Action Recognition [#N-14362]*

Jia-Tao Zhang, Ah-Chung Tsoi and Sio-Long Lo, Macau University of Science and Technology, Macau

In this paper, we apply Scale Invariant Feature Transform (SIFT) Flow, a recently developed method of video representation to human action recognition. SIFT Flow provides a convenient way to express the displacement between keypoints, points which are invariant to scale changes spatially, in two adjacent frames of a video, and it furnishes a compact way to describe the behaviour at keypoints and their neighborhoods as they move in time. A dense trajectory approach using keypoints is developed, and its shape descriptor can be obtained. Local appearance descriptor like histogram of oriented gradients (HOG) evaluated at keypoints, local motion descriptors, like histogram of oriented flows (HOF) and motion boundary histogram (MBH)can be evaluated using SIFT flows. The HOG, HOF MBH, evaluated using SIFT flow, and the keypoint trajectory shape descriptor, together can be used as a feature vector to represent the video. We compare the performance of a number of classifiers to classify the feature vectors, including a bag-of-words approach, support vector machines, linear and nonlinear. It is shown that the proposed novel approach based on keypoints, and SIFT flows produces competitive results when compared with other state-ofthe-art results.

P310 *An Effective Criterion for Pruning Reservoir's Connections in Echo State Networks [#N-14367]*

Simone Scardapane, Gabriele Nocco, Danilo Comminiello, Michele Scarpiniti and Aurelio Uncini, "Sapienza" University of Rome, Italy

Echo State Networks (ESNs) were introduced to simplify the design and training of Recurrent Neural Networks (RNNs), by explicitly subdividing the recurrent part of the network, the reservoir, from the non-recurrent part. A standard practice in this context is the random initialization of the reservoir, subject to few loose constraints. Although this results in a simple-to-solve optimization problem, it is in general suboptimal, and several additional criteria have been devised to improve its design. In this paper we provide an effective algorithm for removing redundant connections inside the reservoir during training. The algorithm is based on the correlation of the states of the nodes, hence it depends only on the input signal, it is efficient to implement, and it is also local. By applying it, we can obtain an optimally sparse reservoir in a robust way. We present the performance of our algorithm on two synthetic datasets, which show its effectiveness in terms of better generalization and lower computational complexity of the resulting ESN. This behavior is also investigated for increasing levels of memory and non-linearity required by the task.

P311 *Similarity-Balanced Discriminant Neighborhood Embedding [#N-14382]*

Chuntao Ding, Li Zhang, Yaping Lu and Shuping He, Soochow University, China

The idea that with the help of proper dimensionality reduction, trying to make the samples with the same label be compact and the ones with the different labels be separate after projection, is introduced into classification problems with high-dimensional data. Based on the analysis of the drawbacks of Discriminant Neighborhood Embedding (DNE) and Locality-Based Discriminant Neighborhood Embedding (LDNE), being the two relatively successful Locally Discriminant Analysis methods proposed in recent years, this paper proposes a method called Similarity-balanced Discriminant Neighborhood Embedding (SBDNE). When constructing the adjacent graph, SBDNE fully takes into account the geometric construction of manifold and the problem of imbalance between the intra-class points and the inter-class points. By endowing these two kinds of samples with different similarities and selecting the near neighbors according to the similarity matrix, not only the structure in the original space can be preserved more efficiently, but also the choice of discriminative information increases. The method proposed here has a better recognition with comparisons to some classical methods, which fully shows that SBDNE method has the capacity to efficiently solve the classification problem.

P312 *Stability of a Neutral Delay Neuron System in the Critical Case [#N-14383]*

Xiaofeng Liao, College of Electronic and Information Engineering, China

In this paper, the asymptotic stability properties of neutral-type neuron system are studied mainly in the critical case when the exponential stability is not possible. In the case of a critical value of the coefficient in neutral-type neuron system, the difficulty for our investigation is because the fact that the spectrum of the linear operator is asymptotically approximated to the imaginary axis. Hence, based on the energy method, the asymptotic stability results for neutral-type neuron system are derived, and a complete analysis of the stability diagram is presented.

P313 *Further Enhancements in WOM Algorithm to Solve the Local Minimum and Flat-Spot Problem in Feed-Forward Neural Networks [#N-14396]*

Chi Chung Cheung, Sin Chun Ng, Andrew K Lui and Sean Shensheng Xu, The Hong Kong Polytechnic University, Hong Kong; The Open University of Hong Kong, Hong Kong

Backpropagation (BP) algorithm is very popular in supervised learning for feed- forward neural networks. However, it is sometimes slow and easily trapped into a local minimum or a flat-spot area (known as the local minimum and flat-spot area problem respectively). Many modifications have been proposed to speed up its convergence rate but they seldom improve the global convergence capability. Some fast learning algorithms have been proposed recently to solve these two problems: Wrong Output Modification (WOM) is one new algorithm that can improve the global convergence capability significantly. However, some limitations exist in WOM so that it cannot solve the local minimum and flat-spot problem effectively. In this paper, some enhancements are proposed to further improve the performance of WOM by (a) changing the mechanism to escape from a local minimum or a flat-spot area and (b) adding a fast checking procedure to identify the existence of a local minimum or a flat-spot area. The performance investigation shows that the proposed enhancements can improve the performance of WOM significantly when it is applied into different fast learning algorithms. Moreover, WOM with these enhancements is also applied to a very popular second- order gradient descent learning algorithm, Levenberg-Marquardt (LM) algorithm. The performance investigation shows that it can significantly improve the performance of LM.

P314 *Extending Dynamic SOMs to Capture Incremental Changes in Data [#N-14443]*

Thushan Ganegedara, Lasindu Vidana Pathiranage, Ruwan Gunarathna, Buddhima Wijeweera, Amal Shehan and Damminda Alahakoon, University of Moratuwa, Sri Lanka; Deakin University, Australia

Humans learn in an incremental manner. Due to this reason, humans continuously refine their knowledge about the world with the experience gained. Many attempts have been made in the machine learning area to employ incremental learning in computer systems. Incremental learning, in contrast to one-time learning is far more useful and effective when data is not completely available at once. Here, we investigate an unsupervised incremental learning algorithm known as IKASL algorithm. IKASL algorithm is capable of capturing knowledge in an incremental manner, without disrupting past knowledge. Furthermore, IKASL algorithm encodes acquired knowledge in such a way that it can be used to acquire new knowledge more efficiently. We identified several limitations of original IKASL algorithm and propose several modifications to the original algorithm which enhances its performance. These modifications include influencing spread factor, introducing fuzzy integral based generalizing technique, etc. Further, experiments were conducted to assess the necessity and value of incremental learning in the real world. The paper reports results of several such experiments conducted with several datasets. These experiments are carefully designed to reflect the interesting characteristics of IKASL algorithm

P315 *Application of Fuzzy Systems in the Control of a Shunt Active Power Filter with Four-Leg Topology [#N-14521]*

Edson Junior Acordi, Ivan Nunes Silva and Ricardo Quadros Machado, Instituto Federal do Parana, Brazil; Universidade de Sao Paulo, Brazil

This paper presents the application of fuzzy controllers to act in the current control loop of a shunt active power filter (SAPF). The SAPF consists of a three- phase inverter with four-leg topology, and it has been used to reduce the harmonic content produced by nonlinear loads, as well as, in the reactive

power compensation. The generation of the reference currents is based on the synchronous reference frame (SRF), which requires the use of a PLL (Phase Locked Loop) synchronization algorithm with the grid. The classic PI control is here replaced by a fuzzy controller that has features that allows fast convergence and robustness when there are parametric variations in the physical system. Results obtained from simulations are presented to validate the approach and to demonstrate the performance of the filter in the suppression of harmonic currents and reactive power.

P316 *Highly Sensitive Weak Signal Acquisition Method for GPS/Compass [#N-14542]*

Song Li, Qing-ming Yi, Min Shi and Qing Chen, Satellite Navigation Chip and Application Technology Research Center of Guangdong College, China

For high sensitivity and operation efficiency in weak signal acquisition of Global Positioning System (GPS) software receiver, a differential coherent accumulated acquisition algorithm based on Fast Fourier Transform (FFT) is proposed. Limitation of coherent combining time was overcome by block accumulation of demodulated GPS intermediate frequency data. Based on FFT frequency shift characteristics, a Doppler circular frequency search was used to achieve low computation instead of frequency compensation search. Loss in frequency was resolved by different down conversions. Compared to the original non-coherent combining, SNR was improved by differential-coherent combining of coherent results. Weak signal in a -39dB poor SNR environment was successfully acquired in experiments. High sensitivity and operation efficiency of the proposed algorithm was confirmed by experiment results.

P317 *Mining User Tasks from Print Logs [#N-14546]*

Xin Li, Lei Zhang, Ping Luo, Enhong Chen, Guandong Xu, Yu Zong and Chu Guan, University of Science and Technology of China, China; HP Labs China, China; University of Technology Sydney, Australia; West Anhui University, China

With lots of applications emerging in World Wide Web, many interaction data from users are collected and exploited to discover user behavior or interest patterns. In this paper, we attempt to exploit a new interaction data, namely print logs, where each record is printing URLs selected by a user using a popular web printing tool. Users usually print web contents based on an intention (subtask or task). Apparently, mining common print tasks from print logs is able to capture users' intentions, which undoubtedly benefits many web applications, such as task oriented recommendation and behavior targeting. However, it is not an easy job to perform this due to the difficulty of URL topic representation and task formulation. To this end, we propose a general framework, named UPT (Users Print Tasks mining framework), for mining print tasks from print logs. Specifically, we attempt to leverage delicious (a social book marking web service) as an external thesaurus to expand the expression of each URL by selecting tags associated with the domain of each URL. Then, we construct a tag co-occurrence graph where similar tags can be clustered as subtasks. If we view each subtask as an item, then the print log is transformed to a transaction database, on which an efficient pattern mining algorithm is proposed to induce tasks. Finally, we evaluate the effectiveness of the proposed framework through experiments on a real print log.

P318 *Adaptive Backstepping-Based Nonlinear Disturbance Observer for Fin Stabilizer System [#N-14551]*

Weiwei Bai and Tieshan Li, Dalian Maritime University, China

In this paper, an adaptive backstepping controller based on nonlinear disturbance observer (DOB) is proposed for the nonlinear fin stabilizer system. DOB is responsible for disturbance rejection and uncertainty compensation, while the adaptive backstepping scheme is proposed for dealing with uncertain parameters of the fin stabilizer model. The designed controller guarantees uniform ultimate boundedness of all the signals in the closed-loop system and the tracking errors converge to a small neighborhood of the origin. The advantages of the proposed control scheme comprise that the DOB decreases the response time and observe the whole disturbances of the fin stabilizer system. Simulation example is given to illustrate that the proposed method can realize the stabilization control of ship more precisely and robustly.

P319 *Multiagent Evolutionary Design of Flexible Beta Basis Function Neural Tree [#N-14555]*

Marwa Ammar, Souhir Bouaziz, Adel M. Alimi and Ajith Abraham, University of Sfax, Tunisia; Machine Intelligence Research Labs, United States

Actually, the Multi-Agent System (MAS) is a very active field. It ensures global coherence between agents' interactions in distributed way and implicit global control. Under the awareness of its power, the application of MAS was no more limited to very specific problems, but to almost application area: optimization, neural network, robotics, fuzzy system, etc. In the other side, a complex system of Artificial Neural Network called Flexible Beta Basis Function Neural Tree (FBBFNT) has reached a great level in the prediction search domain. In the purpose of enlarging the application of the algorithm to complex applications of the real problems, a new architecture of MAS was designed and applied to the FBBFNT process. This new multi-agent system based on communications and negotiations allowed the resolution of more complex prediction problems and the acceleration of the global convergence speed.

P320 *Similarity Michaelis-Menten Law Pre-Processing Descriptor for Face Recognition [#N-14565]*

Suli Ji, Baochang Zhang, Dandan Du and Jianzhuang Liu, Beihang University, China; Huawei, China

This paper presents a non-linear pre-processing method based on Similarity Michaelis-Menten law (SMML) for face recognition. Similarity Michaelis-Menten law can be used to explain visual sensitivity in the vertebrate retina. We preprocess input images using SMML, and then employ Local Binary Pattern (LBP) for face feature extraction. Advantages of SMML include improvement of light adaption, noise effect, detection right rate, robustness and efficiency, which inspire us exploit it for face pre-processing descriptor for the first time in the field of face recognition. And the parameters of SMML are spatiotemporally and locally estimated by the input image itself employing Sobel , which shows its advantages for face recognition. Extensive experiments clearly demonstrate the superiority of our method over the ones which only use LBP on FERET database in many aspects including the robustness against different facial expressions, lighting and aging of the subjects.

P321 *Single Image Super-Resolution via Learned Representative Features and Sparse Manifold Embedding [#N-14573]*

Liao Zhang, Shuyuan Yang, Jiren Zhang and Licheng Jiao, Xidian University, China

Advances in machine learning technology have made efficient Super-Resolution Image Reconstruction (SRIR) possible. In this paper, we advance a hierarchical support vector machine to learn representative features of both training and test Low-Resolution (LR) image patches. Then a sparse manifold assumption is cast on training patch features to find local HR neighbors for each test LR input. The reconstructed High-Resolution (HR) patches can then be derived via Neighbors Embedding (NE) technology with the help of the HR neighbors from training HR patches, and compensated for the LR images. Some experiments are taken on realizing a 3X amplification of natural images, and the recovered results prove its efficiency and superiority to its counterparts.

P322 *Facial Expression Recognition under Random Block Occlusion Based on Maximum Likelihood Estimation Sparse Representation [#N-14581]*

S. S. Liu, Y. Zhang and K. P. Liu, Changchun University of Technology, China

Occlusion is a big challenge for facial expression recognition and previous efforts are largely limited to a few occlusion types without considering the random characteristic of occlusion. Since the original sparse coding model actually assumes that the coding residual follows the Gaussian distribution, which may not be accurate enough to describe the coding errors in practice, so we propose a new scheme by modeling the sparse coding as a sparsely constrained robust regression problem in this paper. Firstly, in order to reduce the influence of occlusion for facial expression, the test facial expression image will be assigned different weights in all pixels. Secondly, because the occluded pixels should have lower weight values, hence, we update the weight through constant iterative until the convergence is achieved. Finally, the final sparse representation of test image can be calculated using the optimal weight matrix. And the class of test image can be determined by the minimal residual which associated with each class of training samples to the test image. The proposed method achieves better performance in JAFFE database and Cohn-Kanade database and experimental results show that it is robust to facial expression recognition under random block occlusion.

P323 *Non-Singular Terminal Sliding Mode Control for Landing on Asteroids Based on RBF Neural Network [#N-14589]*

K. P. Liu, F. X. Liu, S. S. Liu and Y. C. Li, Changchun University of Technology, China

A method of non-singular Terminal sliding mode control was proposed for landing asteroids with uncertainty and strong nonlinearity based on RBF neural network. The dynamics of the detector in the landing environment was analyzed, and the nominal trajectory guidance method based on optimal polynomial was designed, by which the consumption of fuel was suboptimal. Controller was designed using non-singular Terminal sliding mode. The influences caused by unknown disturbance and uncertainty during landing phase was compensated by RBF neural network real-time compensation, which could effectively suppress the influence of external disturbance and weaken the system chattering. Simulation results show that the proposed method was effective.

P324 *Automatic Forest Species Recognition Based on Multiple Feature Sets [#N-14595]*

Marcelo N. Kapp, Rodrigo Bloot, Paulo R. Cavalin and Luiz E. S. Oliveira, Universidade Federal da Integracao Latino-Americana, Brazil; IBM, Brazil; Universidade Federal do Parana, Brazil

In this paper we investigate the use of multiple feature sets for automatic forest species recognition. In order to accomplish this, different feature sets are extracted, evaluated, and combined into a framework based on two approaches: image segmentation and multiple feature sets. The experimental results on microscopic and macroscopic images of wood indicate that the recognition rates can be improved from 74.58% to about 95.68% and from 68.69% to 88.90%, respectively. In addition, they reveal us the importance of exploring different window sizes and appropriate local estimation functions for the LPQ descriptor, further than the classical uniform and gaussian functions.

P325 *Approximate Planning in POMDPs via MDP Heuristic [#N-14330]*

Yong Lin, Xingjia Lu and Makedon Fillia, Ningbo University of Technology, China; University of Texas at Arlington, United States

MDP heuristic based POMDP algorithms have been considered as simple, fast, but imprecise solutions. This paper provides a novel MDP heuristic value iteration algorithm for POMDPs. Besides the help of MDP, our algorithm utilizes a weighted graph model for the belief point approximation and reassignment, to further improve the efficiency and decrease the space complexity. Experimental results indicate our algorithm is fast and has high solution quality for POMDP problems.

P326 *A Neural Network Left-Inversion Flux Estimation for Induction Motor Filed-Oriented Control [#N-14333]*

Hao Zhang, Guohai Liu, Li Qu and Yan Jiang, University of Jiangsu, China

This paper presents a new rotor flux estimation algorithm using neural network for induction motors, based on the left-inversion method. Using the fifth order model of the three-phase induction machines in a stationary two axes reference frame, a rotor flux "assumed inherent sensor" is constructed and its left- invertible is validated. The ANN left-inversion flux estimator is composed of two relatively independent parts - a static ANN used to approximate the complex nonlinear function and several differentiators used to represent its dynamic behaviors, so that the ANN left-inversion is a special kind of dynamic ANN in essence. The performance of the proposed algorithm is tested through simulation, proving the driven system has good behavior both in transient and steady-state operating conditions.

P327 *The Transformer Fault Diagnosis Combing KPCA with PNN [#N-14335]*

Chenxi Dai, Zhigang Liu and Yan Cui, Southwest Jiaotong University, China

The probabilistic neural network (PNN) can detect the complex relationships and be used to develop its basis for the interpretation of dissolved gas-in-oil data that can identify the fault types. An efficient algorithm known as the kernel principle component analysis (KPCA) is applied to increase features in order to get higher detection accuracy. KPCA reflects the nonlinear or high order features that permit to represent and classify the varying states. More features can be obtained by the nonlinear transformation of KPCA, which can realize the biggest between-class margin of the classifiers. In this paper, we apply the method of combining KPCA with PNN in transformer fault diagnosis. The method has more superior performance than traditional PNN alone method. The property of the nonlinear extension of original data of KPCA can obtain the higher diagnosis accuracy, which can achieve better classification and diagnosis.

P328 *Classifying Web Documents Using Term Spectral Transforms and Multi-Dimensional Latent Semantic Representation [#N-14337]*

Haijun Zhang, Shifu Bie and Bin Luo, Harbin Institute of Technology, China

This research investigates the potential of docu- ment semantic representation considering both term frequencies and term associations. In particular, we proposed a general framework of the use of term spectra to represent term spatial distributions and associations through a document. The term spectra we explored involved the use of three typical techniques: Discrete Cosine Transform (DCT), Discrete Fourier Transform (DFT), and Discrete Wavelet Transform (DWT). A term affinity graph was established to represent each document. We then em- ployed a new document analysis method (recently developed by authors), named Multi-Dimensional Latent Semantic Analysis (MDLSA), which enables us to formulate an efficient semantic representation of a document based on the term affinity graph. Our algorithm was examined in the application of Web document classification. Experimental results demonstrate that the proposed technique not only gains much computational efficiency compared to Direct Graph Matching (DGM), but also outperforms the state-of-art algorithms such as VSM, PCA, RAP, and MLM.

P329 *A Hopfield Neural Network Based Algorithm for Haplotype Assembly from Low-Quality Data [#N-14352]*

Xiao Chen, Qinke Peng, Libin Han and Xiao Wang, Xi'an Jiaotong University, China

The objective of the haplotype assembly problem is to conclude a pair of haplotypes from a set of aligned single nucleotide polymorphism (SNP) fragments from a single individual. Errors in the SNP fragments, which are inevitable in the real-world application, severely increase the difficulty of the problem. As a result, most methods could not get accurate haplotypes on the data with high error rate. In this paper, we introduce a Hopfield neural network based method, named HNHap, to solve the haplotype assembly problem. Hopfield neural network is a very promising and effective approach to solve the combinatorial optimization problem. The stochastic optimal competitive Hopfield network model that has the mechanism to escape from the local optimum is a great improvement for the original model. Thus we map the haplotype assembly problem onto the stochastic optimal competitive Hopfield network model, in which a group of neurons correspond to an SNP fragment and the states of neurons denote the classification of the fragment. We also design a proper energy function based on the minimum error correction model for the haplotype assembly problem. We compare HNHap with other algorithms and the experiment results show that HNHap is an effective method to solve the haplotype assembly problem, especially on data with high error rate.

P330 *Distributed Control for Second-Order Leader-Following Multi-Agent Systems with Heterogeneous Leader [#N-14389]*

Hongjing Liang, Yingchun Wang, Zhanshan Wang and Huaguang Zhang, Northeastern University, China

In this paper, distributed control for second-order leader-following multi-agent systems has been solved. All the outputs of the agents reach a common trajectory. The dynamic of the leader agent is different with the follower agents. If the digraph contains a spanning tree, then the problem is solved using an appropriate control law. A compensator is designed to making the closed-loop system matrix stable. Simulation results are further presented to show the effectiveness and performance of our work.

P331 *A Multiplicative Update Algorithm for Nonnegative Convex Polyhedral Cone Learning [#N-14397]*

Qizhao Cai, Kan Xie and Zhaoshui He, Guangdong University of Technology, China

The nonnegative convex polyhedral cone (NCPC) learning is discussed in this paper. By exploiting the multiplicative update nonnegative quadratic programming, a multiplicative update algorithm is developed for NCPC learning. The proposed algorithm is promising for nonnegative matrix factorization (NMF) and we verify this by numerical experiments.

P332 *Neural-Based Adaptive Integral Sliding Mode Tracking Control for Nonlinear Interconnected Systems [#N-14402]*

Wen-Shyong Yu and Chien-Chih Weng, Tatung University, Taiwan

It is proposed here to use a robust tracking design neural-based adaptive integral sliding mode control technique to control nonlinear interconnected systems with unknown coupled uncertainty in which each uncertainty is assumed to be bounded by an unknown gain. A neural network for nonlinear interconnected systems is then proposed for solving the uncertainties of nonlinear interconnected systems. On-line estimation schemes are developed to overcome the uncertainties and identify the gains of the unknown coupled uncertainty, simultaneously. By the concept of parallel distributed compensation (PDC), we combine adaptive neural scheme the integral sliding mode control scheme to resolve the system uncertainties, unknown coupled uncertainties, and the external disturbances such that H_∞ tracking performance is achieved. Simulation results are further presented to show the effectiveness and performance of the proposed control scheme.

P333 *IR Remote Sensing Image Registration Based on Multi-Scale Feature Extraction [#N-14410]*

Jun Kong, Min Jiang and Yi-Ning Sun, Institute of Intelligent Machines, Chinese Academy of Sciences, China; Jiangnan University, China

Infrared remote sensing image has poor contrast and lower SNR so that real-time and robustness are not superior in image registration. In order to solve it, a novel registration based on Multi-scale feature extraction is proposed in this paper. This algorithm is designed in two aspects. Firstly, Gaussian convolution template size adjusts adaptively with the increasing of scale factors. Then the Multi-space is reconstructed. Secondly, feature points bidirectional matching based on the City-block distance is introduced into image registration. So the real-time performance and robustness are enhanced further. Finally, the experimental results showed that by this improved algorithm the infrared remote sensing images are registered more quickly and accurately than by traditional SIFT algorithm.

P334 *Learning Rates of Neural Network Estimators via the New FNNs Operators [#N-14415]*

Yi Zhao and Dansheng Yu, Hangzhou Dianzi University, China; Hangzhou Normal University, China

In this paper, estimation of a regression function from independent and identically distributed random variables is investigated. The regression estimators are defined by minimization of empirical least-square regularized algorithm over a class of functions, which are defined by the feed forward neural networks (FNNs). In order to derive the learning rates of these FNNs regression function estimators, the new FNNs operators are constructed via modified sigmoidal functions. Vapnik-Chervonenkis dimension (V-C dimension) of the class of FNNs functions is also discussed. In addition, the direct approximation theorem by the neural network operators in $L_{\rho_{X}}^{2}$ with Borel probability measure ρ is established.

P335 *Image Encryption Based on Compressed Sensing and Blind Source Separation [#N-14418]*

Zuyuan Yang, Yong Xiang and Chuan Lu, Guangdong University of Technology, China; Deakin University, Australia

A novel image encryption scheme based on compressed sensing and blind source separation is proposed in this work, where there is no statistical requirement to plaintexts. In the proposed method, for encryption, the plaintexts and keys are mixed with each other using a underdetermined matrix first, and then compressed under a project matrix. As a result, it forms a difficult underdetermined blind source separation (UBSS) problem without statistical features of sources. Regarding the decryption, given the keys, a new model will be constructed, which is solvable under compressed sensing (CS) frame. Due to the usage of CS technology, the plaintexts are compressed into the data with smaller size when they are encrypted. Meanwhile, they can be decrypted from parts of the received data packets and thus allows to lose some packets. This is beneficial for the proposed encryption method to suit practical communication systems. Simulations are given to illustrate the availability and the superiority of our method.

P336 *A Modular Neural Network Architecture that Selects a Different Set of Features per Module [#N-14426]*

Diogo Severo, Everson Verissimo, George Cavalcanti and Ing Ren Tsang, Universidade Federal de Pernambuco, Brazil

Modular Neural Network (MNN) divides a problem into smaller and easier sub- problems, and each sub- problem is solved by a neural network called expert. In previous MNN architectures, all experts used the same set of features. This work proposes a modular neural network architecture in which

a specialized set of features is selected per expert. As each expert deals with a different sub- problem, it is expected an improvement in the accuracy rate when different and specialized features are selected per expert. The feature selection procedure is an optimization method based on the binary particle swarm optimization. Experimental results over public datasets show that the proposed modular neural network obtains better accuracy rates than literature MNNs.

P337 *Extracting Nonlinear Correlation for the Classification of Single-Trial EEG in a Finger Movement Task [#N-14431]*

Jun Lu, Kan Xie and Zeng Tang, Guangdong University of Technology, China

The famous common spatial patterns (CSP) algorithm has shown to be useful for event-related desynchronization (ERD) feature extraction of multi-channel electroencephalogram (EEG) signals. Actually, CSP only extracts the linear correlation between each pair of channels. The performance of CSP severely depends on the preprocessing. Moreover, CSP and the subsequent classifier are not optimized by the same criteria. In this paper, we investigated the nonlinear correlation between channels with kernel technique, and proposed a unified prediction framework based on linear ridge regression model. This prediction framework integrates preprocessing, feature extraction and classification, can automatically select the time windows, frequency bands and regularization parameter by minimizing leave-one- out cross-validation error through gradient descent. Experimental results on the dataset IV, BCI competition II show the effectiveness of our approach.

P338 *Vessel Maneuvering Model Identification Using Multi-Output Dynamic Radial-Basis-Function Networks [#N-14435]*

Ning Wang, Nuo Dong and Min Han, Dalian Maritime University, China; Dalian University of Technology, China

In this paper, a vessel maneuvering model (VMM) based on multi-output dynamic radial-basis-function network (MDRBFN) is proposed. Data samples used for training and testing are obtained from the vessel maneuvering dynamics based on a group of nonlinear differential equations. In order to identify the vessel maneuvering model, the differential equations are transformed into nonlinear state-space form. Considering that the desired states are not only dependent on system inputs, i.e., rudder defection and propeller revolution, but also previous states, the proposed MDRBFN is focus on the multi-input multi-output (MIMO) case. The structure of traditional fixed-size RBF networks is difficult to determine, so the growing and pruning algorithm is introduced to multi- output RBF networks to realize RBF networks with dynamic structure. The MDRBFN starts with no hidden neurons, and during the learning process, hidden neurons are recruited automatically according to hidden nodes generation criteria and parameters estimation. In addition, insignificant hidden nodes would be deleted if the node significance is lower than the predefined threshold. As a consequence, the proposed MDRBFN-based VMM (MDRBFN- VMM) reasonably captures the essential maneuvering dynamics with a compact structure. Finally, simulation results indicate that the proposed MDRBFN-VMM achieves promising performance in terms of approximation and prediction.

P339 *Intrusion Detection Using a Cascade of Boosted Classifiers (CBC) [#N-14866]*

Mubasher Baig, El-Sayed El-Alfy and Mian Awais, Lahore University of Management Sciences, Pakistan; King Fahd University of Petroleum and Minerals, Saudi Arabia

A boosting-based cascade for automatic decomposition of multiclass learning problems into several binary classification problems is presented. The proposed cascade structure uses a boosted classifier at each level and use a filtering process to reduce the problem size at each level. The method has been used for detecting malicious traffic patterns using a benchmark intrusion detection dataset. A comparison of the approach with four boosting-based multiclass learning algorithms is also provided on this dataset.

P340 *Data Dimensionality Reduction Approach to Improve Feature Selection Performance Using Sparsified SVD [#N-14019]*

Pengpeng Lin, Jun Zhang and Ran An, University of Kentucky, United States

Feature selection is a technique of selecting a subset of relevant features for building robust learning models. In this paper, we developed a data dimensionality reduction approach using sparsified singular value decomposition (SSVD) technique to identify and remove trivial features before applying any advanced feature selection algorithm. First, we investigated how SSVD can be used to identify and remove nonessential features in order to facilitate feature selection performance. Second, we analyzed the application limitations and computing complexity. Next, a set of experiments were conducted and the empirical results show that applying feature selection techniques on the data of which the nonessential features are removed by the data dimensionality reduction approach generally results in better performance with significantly reduced computing time.

P341 *Visualization and Pattern Discovery of Social Interactions and Repost Propagation in Sina Weibo [#N-14834]*

Xuming Huang, Cong Quan, Shuwei Liu and Yuanyuan Man, The Chinese University of Hong Kong, Hong Kong

Many researchers focus on analysis of social inter- actions and information propagation, but they do not provide results in an intuitive way that helps people understand easily. In this paper, we aim to visualize social interactions of a group of users and repost propagation in Sina Weibo, and seek for patterns from visualization. We propose a new definition to formulate the relationship between users, which reflects their social interactions. We then visualize the data with the help of multidimensional scaling. The result shows an interesting pattern that social interactions among people change corresponding to significant events. Moreover, we visualize repost propagation of hot weibo posts in Sina Weibo. We discover that repost propagation is explosive in the very first time period. And authorized user accounts are helpful for faster and wider propagation. We later choose another popular repost case to support our finding.

P342 *A Transductive Support Vector Machine with Adjustable Quasi-Linear Kernel for Semi-Supervised Data Classification [#N-14519]*

Bo Zhou, Chenlong Hu and Jinglu Hu, Waseda University, Japan

This paper focuses on semi-supervised classification problem by using Transductive Support Vector Machine. Traditional TSVM for semi-supervised classification firstly train an SVM model with labeled data. Then use the model to predict unlabeled data and optimize unlabeled data prediction to retrain the SVM. TSVM always uses a predefined kernel and fixed parameters during the optimization procedure and they also suffers potential over-fitting problem. In this paper we introduce proposed quasi-linear kernel to the TSVM. An SVM with quasi-linear kernel realizes an approximate nonlinear separation boundary by multi-local linear boundaries with interpolation. By applying quasi-linear kernel to semi-supervised classification it can avoid potential over-fitting and provide more accurate unlabeled data prediction. After unlabeled data prediction optimization, the quasi-linear kernel can be further adjusted considering the potential boundary data distribution as prior knowledge. We also introduce a minimal set method for optimizing unlabeled data prediction. The minimal set method follows the clustering assumption of semi-supervised learning. The pairwise label switching is allowed between minimal sets. It can speed up optimization procedure and reduce influence from label constrain in TSVM. Experiment results on benchmark gene datasets show that the proposed method is effective and improves classification performances.

P343 *Multi-Kernel Linear Programming Support Vector Regression with Prior Knowledge [#N-14023]*

Jinzhu Zhou, Key Laboratory of Electronic Equipment Structure Design of Ministry of Education, Xidian University, China

This paper proposes a multi-kernel linear program support vector regression with prior knowledge in order to obtain an accurate regression model in the case of the scarcity of measured data available. In the algorithm, multi-kernel and prior knowledge which may be exact or biased from a calibrated simulator have been incorporated into the framework of linear programming support vector regression by utilizing multiple feature spaces and modifying optimization formulation. Some experiments from a synthetic example have been carried out, and the results show that the proposed algorithm is effective, and that the obtained model is sparse and accurate. The proposed algorithm shows great potential in some practical applications where the experimental data is few and the prior knowledge from a simulator is available.

P344 *An Autonomous Trader Agent for the Stock Market Based on Online Sequential Extreme Learning Machine Ensemble [#N-14781]*

Rodolfo C. Cavalcante and Adriano Oliveira, Federal University of Pernambuco, Brazil

Financial markets are very important to the economical and social organization of modern society. In this kind of market, the success of an investor depends on the quality of the information he uses to trade in the market, and on how fast he is able to take decisions. In the literature, several statistical and soft computing mechanisms have been proposed in order to support investors decision in the financial market. In this work we propose an autonomous trader agent that is able to compute technical indicators of the stock market and take decisions on buying or selling stocks. Our trader agent is based on a single hidden layer feedforward (SLFN) ensemble trained with online sequential extreme learning machine (OS-ELM), a variant of ELM that is able to learn data one-by-one and dynamically accommodate changes in the market. In addition, we propose a set of trading rules that guides the trader agent in order to improve the potential profit. Experimental results on real dataset from Brazilian stock market showed that our proposed trader agent based on OS-ELM ensemble is able to increase the financial gain when compared with other approaches proposed in literature.

P345 *An Ordinal Kernel Trick for a Computationally Efficient Support Vector Machine [#N-14798]*

Yara Rizk, Nicholas Mitri and Mariette Awad, American University of Beirut, Lebanon

A principled approach to machine learning (ML) problems because of its mathematical foundations in statistical learning theory, support vector machines (SVM) requires all the data to be available during the training phase, like non- parametric methods. However, once the model parameters are identified, SVM relies on and depends only, for future prediction, on a subset of these training instances, called support vectors (SV). The SVM model is mathematically written as a weighted sum of these SV whose number, rather than the dimensionality of the input space, defines SVM's complexity. Since the final number of these SV can be up to half the size of the training dataset, and the optimization process could be cubic with respect to the input space, SVM becomes challenged to run on energy aware computing platforms. Because SVM is an optimal classifier, we propose in this work Knee-Cut SVM (KCSVM) and Knee-Cut Ordinal Optimization inspired SVM (KCOOSVM) that use a soft trick of ordered kernel values and uniform subsampling to reduce SVM's prediction computational complexity while maintaining an acceptable impact on its generalization capability. When tested on several databases from UCI, KCSVM and KCOOSVM produced promising results, comparable to similar published algorithms.

Tuesday, July 8, 4:00PM-6:00PM

Special Session: TuN2-1 International Workshop on Computational Energy Management in Smart Grids II

Tuesday, July 8, 4:00PM-6:00PM, Room: 308, Chair: Dongbin Zhao and Haibo He

4:00PM *Kernel Canonical Variate Analysis Based Management System for Monitoring and Diagnosing Smart Homes [#N-14711]*

Andrea Giantomassi, Francesco Ferracuti, Sabrina Iarlori, Sauro Longhi, Alessandro Fonti and Gabriele Comodi, Universita' Politecnica delle Marche, Italy

In the contest of household energy management, a growing interest is addressed to smart system development, able to monitor and manage resources in order to minimize wasting. One of the key factors in curbing energy consumption in the household sector is the amendment of occupant erroneous behaviours and systems malfunctioning, due to the lack of awareness of the final user. Indeed the benefits achievable with energy efficiency could be either amplified or neutralized by, respectively, good or bad practices carried out by the final users. Authors propose a diagnostic system for home energy management application able to detect faults and occupant behaviours. In particular a nonlinear monitoring method, based on Kernel Canonical Variate Analysis, is developed. To remove the assumption of normality, Upper Control Limits are derived from the estimated Probability Density Function through Kernel Density Estimation. The proposed method is applied to smart home temperature sensors to detect anomalies respect to efficient user behaviours and sensors and actuators faults. The method is tested on experimental data acquired in a real apartment.

4:20PM *Frequency Control Using On-Line Learning Method for Island Smart Grid with EVs and PVs [#N-14722]*

Yufei Tang, Jun Yang, Jun Yan, Zhili Zeng and Haibo He, University of Rhode Island, United States; Wuhan University, China

Due to the intermittent power generation from renewable energy in the smart grid (i.e., photovoltaic (PV) or wind farm), large frequency fluctuation occurs when the load frequency control (LFC) capacity is not enough to compensate the unbalance of generation and load demand. This problem may become worsen when the system is in island operating. Meanwhile, in the near future, electric vehicles (EVs) will be widely used by customers, where the EV station could be treated as dispersed battery energy storage. Therefore, the vehicle-to-grid (V2G) power control can be applied to compensate for inadequate LFC capacity, thus improving the island smart grid frequency stability. In this paper, an on-line learning method, called goal representation adaptive dynamic programming (GrADP), is adopted to coordinate control of units in an island smart gird. In the controller design, adaptive supplementary control signals are provided to PI controllers by online GrADP according to the utility function. Simulations on a benchmark smart gird with micro turbine (MT), EVs and PVs demonstrate the superior control effect and robustness of the proposed coordinate controller over the original PI controller and fuzzy controller

4:40PM *Home Energy Management Benefits Evaluation Through Fuzzy Logic Consumptions Simulator [#N-14758]*

Lucio Ciabattoni, Massimo Grisostomi, Gianluca Ippoliti and Sauro Longhi, Universita' Politecnica delle Marche, Italy

In recent years the European Union and, moreover, Italy has seen a rapid growth in the photovoltaic (PV) sector, following the introduction of the feed in tariff (FIT) scheme known as Conto Energia. In July 2013 the Italian government definitively cut FITs, leaving only tax benefits and a revised net metering scheme (known as "Scambio sul Posto") for new PV installations. In this scenario, the design of a new PV plant ensuring savings on electricity bills is strongly related to household electricity consumption patterns. This paper presents a high-resolution model of domestic electricity use based on Fuzzy Logic Inference System. Using as inputs patterns of active occupancy and typical domestic habits, the fuzzy model give as output the likelihood to start each appliance within the next minute. The focus of this work is the use of this novel fuzzy model to correctly size a residential photovoltaic plant and evaluate the economic benefits of energy management actions in a case study. A cost benefits analysis is presented to quantify its effectiveness in the new net metering Italian scenario.

5:00PM *Reactive Power Control of DFIG Wind Farm Using Online Supplementary Learning Controller Based on Approximate Dynamic Programming [#N-14782]*

Wentao Guo, Feng Liu, Dawei He, Jennie Si, Ronald Harley and Shengwei Mei, Tsinghua University, China; Georgia Institute of Technology, United States; Arizona State University, United States

Dynamic reactive power control of doubly fed induction generators (DFIGs) plays a crucially important role in maintaining transient stability of power systems with high penetration of DFIG based wind generation. Based on approximate dynamic programming (ADP), this paper proposes an optimal adaptive supplementary reactive power controller for DFIGs. By augmenting a corrective regulation signal to the reactive power command of rotor-side converter (RSC) of a DFIG, the supplementary controller is designed to reduce voltage sag at the point of common connection (PCC) during a fault, and to mitigate output active power oscillation of the wind farm after a fault. As a result, the transient stability of both DFIG and the power grid is enhanced. An action dependent cost function is introduced to provide real-time online ADP learning control. Furthermore, a policy iteration algorithm using high-efficiency least square method is employed to train the supplementary controller in an online model-free manner. By using such techniques, the supplementary reactive power controller is endowed with capability of online optimization and adaptation. Simulations carried out on a benchmark power system integrating a large DFIG wind farm show that the ADP based supplementary reactive power controller can significantly improve the transient system stability in changing operation conditions.

5:20PM *A Hierarchical Classification Algorithm for Evaluating Energy Consumption Behaviors [#N-14792]*

Li Bu, Dongbin Zhao, Yu Liu and Qiang Guan, Institute of Automation Chinese Academy of Sciences, China; Institute of Automation, Chinese Academy of Sciences, China

Researches on office building energy consumption have been hot in these years, but few researchers consider the classification of office energy consumption performance which can evaluate user behaviors in order to offer a clear analysis of energy consumption and improve their energy saving consciousness. In this paper, we propose a novel hierarchical classification algorithm for evaluating energy consumption behaviors at a real energy management system, which combines fuzzy c-means clustering with GA (genetic algorithm)-based SVM (support vector machine) to fully utilize collected samples. The experiment results with real energy consumption data show that the proposed algorithm works well to distinguish the abnormal behaviors and classify energy consumption behaviors accurately on normal offices.

Special Session: TuN2-2 Neural Networks Applied to Vision and Robotics I

Tuesday, July 8, 4:00PM-6:00PM, Room: 305A, Chair: Jose Garcia Rodriguez and Jorge Azorin

4:00PM *Augmenting the NEAT Algorithm to Improve Its Temporal Processing Capabilities [#N-14201]*

Pilar Caamano, Francisco Bellas and Richard Duro, Universidade da Coruna, Spain

This paper is concerned with the incorporation of new time processing capacities to the Neuroevolution of Augmenting Topologies (NEAT) algorithm. This algorithm is quite popular within the robotics community for the production of trained neural networks without having to determine a priori their size and topology. However, and even though the algorithm can address temporal processing issues through its capacity of establishing feedback synaptic connections, that is, through recurrences, there are still instances where more precise time processing may go beyond its limits. In order to address these cases, in this paper we describe a new implementation of the NEAT algorithm where trainable synaptic time delays are incorporated into its toolbox. This approach is shown to improve the behavior of neural networks obtained using NEAT in many instances. Here, we provide some of these results using a series of typical complex time processing tasks related to chaotic time series modeling and consider an example of the integration of this new approach within a robotic cognitive architecture.

4:20PM *3D Colour Object Reconstruction Based on Growing Neural Gas [#N-14292]*

Sergio Orts-Escolano, Jose Garcia-Rodriguez, Vicente Morell, Miguel Cazorla and Juan Manuel Garcia-Chamizo, University of Alicante, Spain

With the advent of low-cost 3D sensors and 3D printers, surface reconstruction has become an important research topic in the last years. In this work, we propose an automatic method for 3D surface reconstruction from raw unorganized point clouds acquired using low-cost sensors. We have modified the Growing Neural Gas (GNG) network, which is a suitable model because of its flexibility, rapid adaptation and excellent quality of representation, to perform 3D surface reconstruction of different real-world objects. Some improvements have been made on the original algorithm considering colour information during the learning stage and creating complete triangular meshes instead of basic wire-frame representations. The proposed method is able to create 3D faces online, whereas existing 3D reconstruction methods based on Self-Organizing Maps (SOMs) required post-processing steps to close gaps and holes produced during the 3D reconstruction process. Performed experiments validated how the proposed method improves existing techniques removing post-processing steps and including colour information in the final triangular mesh.

4:40PM *3D Maps Representation Using GNG [#N-14721]*

Vicente Morell, Miguel Cazorla, Sergio Orts-Escolano and Jose Garcia-Rodriguez, University of Alicante, Spain

Current RGB-D sensors provide a big amount of valuable information for mobile robotics tasks like 3D map reconstruction, but the storage and processing of the incremental data provided by the different sensors through time quickly becomes unmanageable. In this work, we focus on 3D maps representation and we propose the use of a Growing Neural Gas (GNG) network as a 3D representation model of the input data. GNG method is able to represent the input data with a desired amount of neurons while preserving the topology of the input space. Experiments show how GNG method yields better input space adaptation than other state-of-the-art 3D map representation methods.

5:00PM *Intelligent Visual Servoing for Nonholonomic Mobile Robots [#N-14749]*

Carlos Lopez-Franco, Michel Lopez-Franco, Edgar Sanchez and Alma Y. Alanis, University of Guadalajara, Mexico; The Center for Research and Advanced Studies of the National Polytechnic Institute, Mexico

In this work the authors present a visual servoing approach based on particle swarm optimization (PSO-PBVS). The PSO-PBVS algorithm overcomes the traditional PBVS approach by ensuring that the features will be in the image plane, with the benefits of the PBVS to define the 3D trajectory in the task space. In addition, an intelligent control is used to estimate the currents for each motor, and ensure that the motors provide the desired velocities.

5:20PM *A Predictive Model for Recognizing Human Behaviour Based on Trajectory Representation [#N-14797]*

Jorge Azorin-Lopez, Marcelo Saval-Calvo, Andres Fuster-Guillo and Antonio Oliver-Albert, University of Alicante, Spain

The automatic understanding of the behaviour conducted by humans in scenarios using images as input of the system is a very important and challenging problem involving different areas of computational intelligence. In this paper human activity recognition is studied from a prediction point of view. We propose a model that, in addition to the capabilities of it to predict behaviour from new inputs, it is able to detect behaviour using a portion of the input. Specifically, we propose a prediction activity method based on the Activity Description Vector (ADV) to early detect the behaviour performed by a person in a scene. ADV is used to extract features that are normalized to be the cue of behaviour classifiers. We use complete sequences for training and partial sequences to evaluate the prediction capabilities having a specific observation time of the scene. CAVIAR dataset and different classic classifiers have been used for experimentation in order to evaluate the proposal obtaining great accuracy on the early recognition.

5:40PM *Facial Expressions Recognition System Using Bayesian Inference [#N-14600]*

Maninderjit Singh, Anima Majumder and Laxmidhar Behera, Indian Institute of Technology Kanpur, India

The paper presents a facial expressions recognition system using Bayesian network. We propose features extraction methods to get geometric feature vector containing angular informations and appearance feature vector containing moments extracted after applying gabor filter over certain facial regions. Both the feature vectors are further used to draw relationships among Action Units (AUs). The angular informations are directly extracted from the facial landmark points. The geometric features extraction approach contains only 22 dimensional angular informations against direct facial landmarks based approach that contains 136 dimensional feature vector. Facial activities are represented by three distinct layers. Bottom level contains landmark measurement data with angular features. Middle level has facial AUs those are coded in facial action coding system (FACS) and the top level, represents emotion node. We also propose a method using k-means clustering to automatically define the states of nodes in anatomical layer that draws relationship among AUs and measurement data. Extended Cohn Kanade Database is being used for our experimental purposes. An average emotion recognition accuracy of 95.7% is achieved using proposed Bayesian network based approach for 22 dimensional angular feature vector. To verify the performance of the proposed approach we apply three different classifiers such as, Support vector machine, Decision tree and Radial basis functions network. The confusion matrices show that the Bayesian network based classification approach outperforms all other applied approaches. The experimental results illustrates the effectiveness of the proposed model.

Special Session: TuN2-3 Autonomous Learning

Tuesday, July 8, 4:00PM-6:00PM, Room: 305B, Chair: Plamen Angelov and Asim Roy

4:00PM *A Computationally Fast Interval Type-2 Neuro-Fuzzy Inference System and Its Meta-Cognitive Projection Based Learning Algorithm [#N-14381]*

Ankit Kumar Das, Kartick Subramanian and Suresh Sundaram, Nanyang Technological University, Singapore

In this paper, a computationally efficient Interval Type-2 Neuro-Fuzzy Inference System (IT2FIS) and its Meta-Cognitive projection based learning (PBL) algorithm is presented, together referred as PBL-McIT2FIS. A six layered network with computationally cheap type-reduction technique is proposed, rendering the inference mechanism faster. During learning, the projection based learning algorithm assumes that IT2FIS has no rules in the beginning, and the learning algorithm adds rules to the network and updates it depending on the prediction error and relative knowledge present in the current sample. As each sample is presented to the network, the meta-cognitive component of the learning algorithm decides what-to-learn, when-to-learn and how-to-learn it, depending on the instantaneous error and spherical potential of the current sample. Whenever a new rule is added or an existing rule is updated, a projection based learning algorithm computes the optimal output weights by minimizing the total error in the network in a computationally efficient manner. The performance of PBL- McIT2FIS is evaluated on a set of benchmark problem and compared to other state-of-the-art algorithms available in literature. The results indicate superior performance of PBL-McIT2FIS.

4:20PM *WWN: Integration with Coarse-to-Fine, Supervised and Reinforcement Learning [#N-14517]*

Zejia Zheng, Juyang Weng and Zhengyou Zhang, Michigan State University, United States; Microsoft Research, United States

The cost of autonomous development is substantial. Although supervised learning is effective, the cost demand on teachers is often too high to be constantly applied. Reinforcement learning can take advantage of physical reality due to environmental feedback and inspections. Information required in reinforcement learning is not as specific as is required in supervised learning. Integration theories, methods, and analysis of these two learning strategies are still rare in the literature although such integration has been well known in the animal kingdom. Based on our prior work on a general purpose framework called Developmental Network and its embodiment Where-What-Network, we present our theory, method, and analysis for integration of supervised learning and reinforcement learning in this paper. Different from all other known work on reinforcement learning, this DN framework uses fully emergent representation to avoid the brittleness and task-specific representations. Central in the integration is not just to provide a freedom for the teacher to choose the mode of learning, which is necessary especially when the physical non-living world is an implicit teacher, but the mechanism of scaffolding. In our experiment the scaffolding is reflected by allowing the location motor(LM) neurons to gradually refine representation through splitting(mitosis) in a coarse to fine scheme. We report our experimental work in a very challenging learning setting: both object and backgrounds are unknown(cluttered settings) and concepts(e.g. location and type) emerge from agent-environment interactions, instead of rigidly handcrafted.

4:40PM *From Here to AGI: A Roadmap to the Realization of Human-Level Artificial General Intelligence [#N-14682]*

Ben Goertzel, Novamente LLC, United States

A practical roadmap to human-level artificial general intelligence is outlined, leading from the current situation in which complex AGI-oriented cognitive architectures remain partially implemented and inadequately tested, to a future in which AGI systems are deployed to carry out a variety of practical tasks currently only achievable via humans. The roadmap involves simultaneous development of proto-AGI applications in a number of different areas: videogame agent control, mobile robotics, genomics, natural language dialogue, theorem proving and program learning. The simultaneous pursuit of diverse application areas using a single AGI architecture is proposed as critical to maintaining generality of intelligence throughout the development process. While acknowledging the profound difficulty of time estimation for a project of this complexity, it is projected that the roadmap outlined could potentially be completed in a decade or less.

5:00PM *A Fast Learning Variable Lambda TD Model Used to Realize Home Aware Robot Navigation [#N-14743]*

Abdulrahman Altahhan, American University in the Emirates, United Arab Emirates

This work describes a fast learning robot goal-aware navigation model that employs both gradient and conjugate gradient Temporal Difference (TD, TD-conj) methods. It builds on the fact that TD-conj was proven to be equivalent to a gradient TD method with a variable lambda under certain conditions. Based on straightforward features extraction process combined with goal-aware capabilities provided by whole image measure, the model solves what we call u- turn-homing benchmark problem without using landmarks. Only one goal snapshot was used with agent facing the goal directly. Therefore a novel threshold stopping formula was used to recognize the goal which is less sensitive to the agent-goal orientation problem. Unlike other models, this model refrains from artificially manipulating or assuming a priori knowledge about the environment, two constraints that widely restrict the applicability of existing models in realistic scenarios. An on-line control method was used to train a set of neural networks. With the aid of variable and fixed eligibility traces, these networks approximate the agent's action-value function allowing it to take close to optimal actions to reach its home. The effectiveness of the model was experimentally verified on an agent.

5:20PM *User Daily Activity Pattern Learning: A Multi-Memory Modeling Approach [#N-14831]*

Shan Gao and Ah-Hwee Tan, Nanyang Technological University, Singapore

In this paper, we propose a multi-memory model, ADLART model, to discover the daily activity of a sensor monitored user from his/her activities of daily living (ADL). The proposed model mimics the human multiple memory system comprising working memory, episodic memory, and semantic memory components through encoding daily activities in episodic memory and extracting regularities of activity routines in semantic memory. The ADLART system is able to learn, recognize, compare, and retrieve ADL patterns of the user. Experiments are also presented to show the performance of the ADLART model using different parameter settings.

5:40PM *Mobile Humanoid Agent with Mood Awareness for Elderly Care [#N-14844]*

Di Wang and Ah-Hwee Tan, Nanyang Technological University, Singapore

Human, especially elderly, require frequent attention, continuous companionship, and deep understanding from the others. To provide more specific and appropriate tender care to the elderly, knowing their affective states is a great advantage. Recent work on human emotion recognition shows promising results that the expressive emotion can be successfully captured through visual, audio, and keyboard or touchpad stroke pattern signals. Furthermore, human activities are shown to be accurately recognizable with context by non-intrusive sensors within or connected to the smartphones. In this paper, we propose a computational model to characterize the affective states of the elderly based on the recognizable daily activities. Therefore, by integrating such an understanding module into a humanoid agent residing in the smartphone platform, we make the mobile agent more human-like. The initial knowledge of the activity-affect associations is taken from published work in psychology and gerontology. Based on the provided training signals, our model adapts the activity-affect knowledge accordingly. Consequently, by modeling mood awareness of the elderly, our agent can carry out more specific task and provide more appropriate tender care.

6:00PM *A New Unsupervised Approach to Fault Detection and Identification [#N-14949]*

Bruno Costa, Plamen Angelov and Luiz Guedes, Federal University of Rio Grande do Norte, Brazil; Lancaster University, United Kingdom

In this paper, a new fully unsupervised approach to fault detection and identification is proposed. It is based on a two-stage algorithm and starts with the recursive density estimation (RDE) in the feature space. The choice of the features is important and in the real world process that we consider these are control and error related variables. The basis of the proposed approach is the fully unsupervised evolving classifier AutoClass which can be seen as an extension of the earlier one, but is using data clouds and data density information. It has to be stressed that the density in the data space is not the same as the well known and widely used in statistics probability density function (pdf) although it looks similar. The density in the data space, D is pivotal and instrumental for anomaly detection. It can be calculated recursively, which makes it very efficient in terms of memory, computational power and, thus, applicable to on-line applications. Importantly, the proposed method not only can detect anomalies, but also can identify and diagnose the fault during the second stage of the process. While the first stage is centred around RDE, the second stage is based on the evolving fuzzy rule-based (FRB) classifier AutoClass. A key advantage of AutoClass is that it is fully unsupervised (there is no need to pre-specify the fuzzy rules, number of classes) and can start learning "from scratch". AutoClass can be initialised with some prior knowledge (assuming that it does exists) and evolve/develop it further, but that is not mandatory.

TuN2-4 Machine Learning: Complexity and Optimization

Tuesday, July 8, 4:00PM-6:00PM, Room: 305C, Chair: Albert Lam

4:00PM *Dimensionality Reduction Assisted Tensor Clustering [#N-14045]*

Yanfeng Sun, Junbin Gao, Xia Hong, Yi Guo and Chris Harris, Beijing University of Technology, China; Charles Sturt University, Australia; University of Reading, United Kingdom; Commonwealth Scientific and Industrial Research Organisation, Australia; University of Southampton, United Kingdom

This paper is concerned with tensor clustering with the assistance of dimensionality reduction approaches. A class of formulation for tensor clustering is introduced based on tensor Tucker decomposition models. In this formulation, an extra tensor mode is formed by a collection of tensors of the same dimensions and then used to assist a Tucker decomposition in order to achieve data dimensionality reduction. We design two types of clustering models for the tensors: PCA Tensor Clustering model and Non-negative Tensor Clustering model, by utilizing different regularizations. The tensor clustering can thus be solved by the optimization method based on the alternative coordinate scheme. Interestingly, our experiments show that the proposed models yield comparable or even better performance compared to most recent clustering algorithms based on matrix factorization.

4:20PM *Particle Swarm Optimization for Convolved Gaussian Process Models [#N-14077]*

Gang Cao, Edmund M-K Lai and Fakhrul Alam, Massey University, New Zealand

Convolved Gaussian process (CGP) is a type Gaussian process modelling technique applicable for multiple-input multiple-output systems. It employs convolution processes to construct a covariance function that models the correlation between outputs. Modelling using CGP involves learning the hyperparameters of the latent function and the smoothing kernel. Conventionally, learning involves the maximization of the log likelihood function of the training samples using conjugate gradient (CG) or particle swarm optimization (PSO) methods. We propose to use PSO to minimize the model error. In this way, a clearer direct indication of the quality of the current solution during the optimization process can be obtained. Simulation results on a dynamical system show that our method is able to learn appropriate CGP models and achieve better predictive performance compared with CG when the searching space is not well defined.

4:40PM *A Flocking-Like Technique to Perform Semi-Supervised Learning [#N-14117]*

Roberto Gueleri, Thiago Cupertino, Andre Carvalho and Liang Zhao, University of Sao Paulo, Brazil

We present a nature-inspired semi-supervised learning technique based on the flocking formation of certain living species like birds and fishes. Each data item is treated as an individual in the flock. Starting from random directions, each data item moves according to its surrounding items, by getting closer to them (but not too much close) and taking the same direction of motion. Labeled items play special roles, ensuring that data from different classes will belong to different, distant flocks. Experiments on both artificial and benchmark datasets were performed and show its classification accuracy. Despite the rich behavior, we argue that this technique has a sub-quadratic asymptotic time complexity, thus being feasible to be used on large datasets. In order to achieve such performance, a space-partitioning technique is introduced. We also argue that the richness behind this dynamic, self-organizing model is quite robust and may be used to do much more than simply propagating the labels from labeled to unlabeled data. It could be used to determine class overlapping, wrong labeling, etc.

5:00PM *Finding Convex Hull Vertices in Metric Space [#N-14515]*

Jinhong Zhong, Ke Tang and Kai Qin, University of Science and Technology of China, China; Royal Melbourne Institute of Technology, Australia

The convex hull has been extensively studied in computational geometry and its applications have spread over an impressive number of fields. How to find the convex hull is an important and challenging problem. Although many algorithms had been proposed for that, most of them can only tackle the problem in two or three dimensions and the biggest issue is that those algorithms rely on the samples' coordinates to find the convex hull. In this paper, we propose an approximation algorithm named FVDM, which only utilizes the information of the samples' distance matrix to find the convex hull. Experiments demonstrate that FVDM can effectively identify the vertices of the convex hull.

5:20PM *An Identifying Function Approach for Determining Structural Identifiability of Parameter Learning Machines [#N-14625]*

Zhi-Yong Ran and Bao-Gang Hu, Institute of Automation, Chinese Academy of Sciences, China

Structural identifiability (SI) is a fundamental prerequisite for system modeling and parameter estimation. It concerns theoretical uniqueness of model parameters determined from ideal model structure and error-free input-output observations. In this work, we present an identifying function (IF) approach for examining SI of parameter learning machines with the help of Rank Theorem in Riemann geometry. The resulting theorem works by checking the rank of the derivative matrix (DM) of IF. Further, based on the DM, an analytic method for constructing identifiable independent parametric functions is presented. The relationship of structural nonidentifiability, parameter redundancy and parameter dependence is therefore clarified. Several model examples from the literature are presented to examine their identifiability property.

5:40PM *Detection of Non-Structural Outliers for Microarray Experiments [#N-14707]*

Zihua Yang and ZhengRong Yang, University of Queen Mary, United Kingdom; University of Exeter, United Kingdom

Outliers are unavoidable in many experiments due to various complex reasons ranging from equipment resolution to data contamination. The presence of outliers in microarray gene expression data can affect the quality of gene selection and ranking. This effect is severe when a microarray gene expression data is composed of too few samples. We classify outliers occurred in microarray gene expression data as structural and non-structural outliers. Structural outliers are gene dependent or sample dependent (or both) whereas non-structural outliers are gene and sample-independent. They are uninformative to gene expression differentiation but can cause misclassification of a differentially expressed gene as a non-differentially expressed one. While there are algorithms for detecting structural outliers, a different strategy is required for detecting non-structural outliers. We show the impact of non-structural outliers on gene selection/ranking and false discovery rate control. We also show the unsuitableness of existing outlier detection algorithms for detecting non-structural outliers. We propose a new algorithm for detecting non-structural outliers. It models the consecutive differences of ordered gene expressions as exponentially distributed. We use simulated and real data to demonstrate the efficacy of the proposed algorithm in correcting for non-structural outliers and improving gene selection/ranking and false discovery rate control.

TuN2-5 Feature Extraction and Intelligent Systems

Tuesday, July 8, 4:00PM-6:00PM, Room: 305D, Chair: Sung-Bae Cho

4:00PM *Variable Selection for Regression Problems Using Gaussian Mixture Models to Estimate Mutual Information [#N-14310]*

Emil Eirola, Amaury Lendasse and Juha Karhunen, Aalto University, Finland

Variable selection is a crucial part of building regression models, and is preferably done as a filtering method independently from the model training. Mutual information is a popular relevance criterion for this, but it is not trivial to estimate accurately from a limited amount of data. In this paper, a method is presented where a Gaussian mixture model is used to estimate the joint density of the input and output variables, and subsequently used to select the most relevant variables by maximising the mutual information which can be estimated using the model.

4:20PM *Scene Image Classification Using a Wigner-Based Local Binary Patterns Descriptor [#N-14460]*

Atreyee Sinha, Sugata Banerji and Chengjun Liu, New Jersey Institute of Technology, United States

This paper introduces a new local feature description method to categorize scene images. We encode local image information by exploring the pseudo-Wigner distribution of images and the Local Binary Patterns (LBP) technique and make four major contributions. In particular, we first define a multi-neighborhood LBP for small image blocks. Second, we combine the multi-neighborhood LBP with the pseudo-Wigner distribution of images for feature extraction. Third, we derive the innovative WLBP feature vector by utilizing the frequency domain smoothing, the bag-of-words model and spatial pyramid representations of an image. Finally, we perform extensive experiments to evaluate the performance of the proposed WLBP descriptor. Specifically, we test our descriptor for classification performance using a Support Vector Machine (SVM) classifier on three fairly challenging publicly available image datasets, namely the UIUC Sports Event dataset, the Fifteen Scene Categories dataset and the MIT Scene dataset. Experimental results reveal that the proposed WLBP descriptor outperforms the traditional LBP technique and yields results better than some other popular image descriptors.

4:40PM *Integrating Supervised Subspace Criteria with Restricted Boltzmann Machine for Feature Extraction [#N-14139]*

Guo-Sen Xie, Xu-Yao Zhang, Yan-Ming Zhang and Cheng-Lin Liu, National Laboratory of Pattern Recognition, Institute of Institute of Automation, Chinese Academy of Sciences, China

Restricted Boltzmann Machine (RBM) is a widely used building-block in deep neural networks. However, RBM is an unsupervised model which can not exploit the rich supervised information of data. Therefore, we consider combining the descriptive (generative) ability of RBM with the discriminative ability of supervised subspace models, i.e., Fisher linear discriminant analysis (FDA), marginal Fisher analysis (MFA), and heat kernel MFA (hkMFA). Specifically, the hidden layer of RBM is regularized by the supervised subspace criteria, and the joint learning model can then be efficiently optimized by gradient descent and graph construction (used to define the scatter matrix in the subspace models) on mini-batch data. Compared with the traditional subspace models (FDA, MFA, hkMFA), the proposed hybrid models are essentially nonlinear and can be optimized by gradient descent instead of eigenvalue decomposition. More importantly, traditional subspace models can only reduce the dimensionality (because of linear transformation), while the proposed models can also increase the dimensionality for better class discrimination. Experiments on three databases demonstrate that the proposed hybrid models outperform both RBM and their counterpart subspace models (FDA, MFA, hkMFA) consistently.

5:00PM *Semi-Supervised Sparse Coding [#N-14142]*

Jim Jing-Yan Wang and Xin Gao, University at Buffalo, The State University of New York, United States; King Abdullah University of Science and Technology, Saudi Arabia

Sparse coding approximates the data sample as a sparse linear combination of some basic codewords and uses the sparse codes as new presentations. In this paper, we investigate learning discriminative sparse codes by sparse coding in a semi-supervised manner, where only a few training samples are labeled. By using the manifold structure spanned by the data set of both labeled and unlabeled samples and the constraints provided by the labels of the labeled samples, we learn the variable class labels for all the samples. Furthermore, to improve the discriminative ability of the learned sparse codes, we assume that the class labels could be predicted from the sparse codes directly using a linear classifier. By solving the codebook, sparse codes, class labels and classifier parameters simultaneously in a unified objective function, we develop a semi-supervised sparse coding algorithm. Experiments on two real-world pattern recognition problems demonstrate the advantage of the proposed methods over supervised sparse coding methods on partially labeled data sets.

5:20PM *Investigation of Multi-Layer Perceptron with Pulse Glial Chain Based on Individual Inactivity Period [#N-14827]*

Chihiro Ikuta, Yoko Uwate and Yoshifumi Nishio, Tokushima University, Japan

In this study, we propose a Multi-Layer Perceptron (MLP) with pulse glial chain based on individual inactivity period which is inspired from biological characteristics of a glia. In this method, we one-by-one connect a glia with neurons in the hidden-layer. The connected glia is excited by the connecting neuron output. Then, the glia generates the pulse. This pulse is input to the connecting neuron threshold. Moreover, this pulse is propagated into the glia network. Thus, the glia has a position density each other. In this network, a period of inactivity of the glia is dynamically changed according to pulse generation time. In the previous method, we fix the period of inactivity, thus the pulse generation pattern is often fixed. It is similar to the local minimum. By varied the period of inactivity, the pulse generation pattern obtains the diversity. We consider that this diversity of the pulse generation pattern is efficiency to the MLP performance. By the simulation, we confirm that the proposed MLP improves the MLP performance than the conventional MLP.

5:40PM *Identification of Meat Spoilage by FTIR Spectroscopy and Neural Networks [#N-14062]*

Vassilis Kodogiannis, Ilias Petrounias and Eva Kontogianni, University of Westminster, United Kingdom; University of Manchester, United Kingdom; Regional Unit of Heraklion, Greece

Freshness and safety of muscle foods are generally considered as the most important parameters for the food industry. To address the rapid determination of meat spoilage, Fourier transform infrared (FTIR) spectroscopy technique, with the help of advanced learning-based methods, was attempted in this work. FTIR spectra were obtained from the surface of beef samples during aerobic storage at various temperatures, while a microbiological analysis had identified the population of Total viable counts. A fuzzy principal component algorithm has been also developed to reduce the dimensionality of the spectral data. The results confirmed the superiority of the adopted scheme compared to the partial least squares technique, currently used in food microbiology.

TuN2-6 Supervised Learning II

Tuesday, July 8, 4:00PM-6:00PM, Room: 305E, Chair: Fakhri Karray

4:00PM *Max-Dependence Regression [#N-14777]*
Pouria Fewzee, Ali-Akbar Samadani, Dana Kulic and Fakhri Karray, University of Waterloo, Canada

This work proposes an approach for solving the linear regression problem by maximizing the dependence between prediction values and the response variable. The proposed algorithm uses the Hilbert-Schmidt independence criterion as a generic measure of dependence and can be used to maximize both nonlinear and linear dependencies. The algorithm is important in applications such as continuous analysis of affective speech, where linear dependence, or correlation, is commonly set as the measure of goodness of fit. The applicability of the proposed algorithm is verified using two synthetic, one affective speech, and one affective bodily posture datasets. Experimental results show that the proposed algorithm outperforms support vector regression (SVR) in 84% (264/314) of studied cases, and is noticeably faster than SVR, as an order of 25, on average.

4:20PM *K-Associated Optimal Network for Graph Embedding Dimensionality Reduction [#N-14076]*
Murillo Carneiro, Thiago Cupertino and Liang Zhao, University of Sao Paulo, Brazil

In machine learning, dimensionality reduction aims at reducing the dimension of the input data in order to achieve a small set of features that keeps the most important original relationships among data samples. In this paper, we investigate the usage of a non-parametric network formation algorithm into a graph embedding framework to perform supervised dimensionality reduction. Specifically, our technique maps data into networks and constructs two network adjacency matrices which convey information about intra-class components and inter-class penalty connections. Both matrices are inserted into an optimization framework in order to achieve a projection vector that is used to project high- dimension data samples into a low-dimensional space. One advantage of the technique is that no parameter is required, that is, there is no need to select a model for the input data. Computer simulations on real-world data sets have been performed to compare the proposed technique to some classical network formation methods such as k-NN and epsilon-radius, and to well-known dimensionality reduction algorithms such as PCA and LDA. Statistical tests have shown that our approach outperforms those algorithms.

4:40PM *Max-Margin Latent Feature Relational Models for Entity-Attribute Networks [#N-14231]*
Fei Xia, Ning Chen, Jun Zhu, Aonan Zhang and Xiaoming Jin, Tsinghua University, China

Link prediction is a fundamental task in statistical analysis of network data. Though much research has concentrated on predicting entity-entity relationships in homogeneous networks, it has attracted increasing attentions to predict relationships in heterogeneous networks, which consist of multiple types of nodes and relational links. Existing work on heterogeneous network link prediction mainly focuses on using input features that are explicitly extracted by humans. This paper presents an approach to automatically learn latent features from partially observed heterogeneous networks, with a particular focus on entity-attribute networks (EANs), and making predictions for unseen pairs. To make the latent features discriminative, we adopt the max-margin idea under the framework of maximum entropy discrimination (MED). Our maximum entropy discrimination joint relational model (MED-JRM) can jointly predict entity-entity relationships as well as the missing attributes of entities in EANs. Experimental results on several real networks demonstrate that our model has improved performance over state-of-the-art homogeneous and heterogeneous network link prediction algorithms.

5:00PM *Dual Instance and Attribute Weighting for Naive Bayes Classification [#N-14326]*
Jia Wu, Shirui Pan, Zhihua Cai, Xingquan Zhu and Chengqi Zhang, University of Technology Sydney, Australia; China University of Geosciences Wuhan, China; Florida Atlantic University, United States

Naive Bayes (NB) network is a popular classification technique for data mining and machine learning. Many methods exist to improve the performance of NB by overcoming its primary weakness---the assumption that attributes are conditionally independent given the class, using techniques such as backwards sequential elimination and lazy elimination. Some weighting technologies, including attribute weighting and instance weighting, have also been proposed to improve the accuracy of NB. In this paper, we propose a dual weighted model, namely DWNB, for NB classification. In DWNB, we firstly employ an instance similarity based method to weight each training instance. After that, we build an attribute weighted model based on the new training data, where the calculation of the probability value is based on the embedded instance weights. The dual instance and attribute weighting allows DWNB to tackle the conditional independence assumption for accurate classification. Experiments and comparisons on 36 benchmark data sets demonstrate that DWNB outperforms existing weighted NB algorithms.

5:20PM *Learning from Combination of Data Chunks for Multi-Class Imbalanced Data [#N-14469]*
Xu-Ying Liu and Qian-Qian Li, Southeast University, China

Class-imbalance is very common in real-world applications. Previous studies focused on binary-class imbalance problem, whereas multi-class imbalance problem is more general and more challenging. Under-sampling is an effective and efficient method for binary-class imbalanced data. But when it is used for multi-class imbalanced data, many more majority class examples are ignored because there are often multiple majority classes, and the minority class often has few data. To utilize the information contained in the majority class examples ignored by under-sampling, this paper proposes a method ChunkCombine. For each majority class, it performs under-sampling multiple times to obtained non-overlapping data chunks, such that they contain the most information that a data sample of the same size can contain. Each data chunk has the same size as the minority class to achieve balance. Then every possible combination of the minority class and each data chunk from every majority class forms a balanced training set. ChunkCombine uses ensemble techniques to learn from the different training sets derived from all the possible combinations. Experimental results show it is better than many other popular methods for multi-class imbalanced data when average accuracy, G-mean and MAUC are used as evaluation measures. Besides, we discuss different evaluation measures and suggest that, a multi- class F-measure Mean F-Measure (MFM) is unsuitable for multi-class imbalanced data in many situations because it is not consistent with the standard F-measure in binary-class case and it is close to accuracy.

5:40PM *Dual Deep Neural Network Approach to Matching Data in Different Modes [#N-14789]*
Mark Eastwood and Chrisina Jayne, Coventry University, United Kingdom

This paper investigates the application of a novel Deep Neural Network (DNN) architecture to the problem of matching data in different modes. Initially one DNN is pre-trained as a feature extracter using several stacked Restricted Boltzmann Machine (RBM) blocks on the entire training data using unsupervised learning. This DNN is duplicated and each net is fine-tuned by training on the data represented in a specific mode using supervised learning. The target of each DNN is linked to the output from the other DNN thus ensuring matching features are learnt which are adjusted to take differing representation into account. These features are used with some distance metric to determine matches. The expected benefit of this approach is utilizing the capability of DNN to learn higher level features which can better capture the information contained in the input data's structure, while ensuring the differences in data representation are accounted for. The architecture is applied to the problem of matching faces and sketches and the results compared to traditional approaches employing Principal Component Analysis (PCA) or Linear Discriminant Analysis (LDA).

Wednesday, July 9, 1:30PM-3:30PM

Special Session: WeN1-1 International Workshop on Computational Energy Management in Smart Grids III

Wednesday, July 9, 1:30PM-3:30PM, Room: 308, Chair: Stefano Squartini and Francesco Piazza

1:30PM *Computational Framework Based on Task and Resource Scheduling for Micro Grid Design [#N-14371]*

Marco Severini, Stefano Squartini and Francesco Piazza, Universita' Politecnica delle Marche, Italy

Within micro grid scenarios, optimal energy management represents an important paradigm to improve the grid efficiency while lowering its burden. While usually real time energy management is considered, an offline approach can be also adopted to maximize the grid efficiency in certain contexts. Indeed, by evaluating the energy management performance according to the user needs, it is possible to asses which technologies allow the overall system to operate at its best, given the expected load level. From this perspective, a computational framework based on the "Mixed-Integer Linear Programming" paradigm has been proposed in this paper as a tool to simulate the micro grid behaviour in terms of energy consumption and in dependence on the technology of choice. By modelling the energy production and storage means, the pool of electricity tasks, and the thermal behaviour of the building, suitable energy management policies for the micro grid scenario under study can be developed and tested in different operating conditions and time horizons. Moreover, the forecasting paradigm has been integrated into the framework to deal with data uncertainty, and a Neural Network approach has been employed on purpose. Performed computer simulations, related to a six-apartments building scenario, have proven that the suggested framework can fruitfully be adopted to assess the effectiveness of different technical solutions in terms of overall energy cost, thus supporting the decisional process occurring during the micro grid design.

1:50PM *An Optimal Real-Time Pricing for Demand-Side Management: A Stackelberg Game and Genetic Algorithm Approach [#N-14379]*

Fan-Lin Meng and Xiao-Jun Zeng, University of Manchester, United Kingdom

This paper proposes a real-time pricing scheme for demand response management in the context of smart grids. The electricity retailer determines the retail price first and announces the price information to the customers through the smart meter systems. According to the announced price, the customers automatically manage the energy use of appliances in the households by the proposed energy management system with the aim to maximize their own benefits. We model the interactions between the electricity retailer and its customers as a 1-leader, N-follower Stackelberg game. By taking advantage of the two-way communication infrastructure, the sequential equilibrium can be obtained through backward induction. At the followers' side, given the electricity price information, we develop efficient algorithms to maximize customers' satisfaction. At the leader's side, we develop a genetic algorithms based real-time pricing scheme by considering the expected customers' reactions to maximize retailer's profit. Experimental results indicate that the proposed scheme can not only benefit the retailers but also the customers.

2:10PM *A Simulation Based Approach to Forecast a Demand Load Curve for a Container Terminal Using Battery Powered Vehicles [#N-14734]*

Nico Grundmeier, Norman Ihle, Axel Hahn, Claas Meyer-Barlag and Serge Runge, University of Oldenburg, Germany

This article presents a simulation based approach to provide a short-term energy demand load curve forecast in a container terminal. While common methods for forecasting electricity consumption are working well in industrial enterprises with continuous and recurrent production cycles, in a container terminal the processes are highly dynamical. That is why the most common methods are not working well, and a simulation based approach is chosen. If the energy consumption can be forecasted precisely it is possible to benefit from cheaper energy purchase prices. If the container terminal uses battery powered vehicles additional strategies to use the forecast can be employed. One possibility is to reduce the costs by using intelligent strategies for charging the batteries in a battery-exchange station where the energy consumption can be forecasted as well. The important fact is that with the exchange station the load curve can be influenced without interfering in the logistic processes of the terminal because the energy consumption of the transport vessels is decoupled from the logistic processes by the use of batteries. This is why methods like load shifting and peak clipping can be applied quite easily. First, a simulation based approach is introduced to calculate a reliable load forecast of the entire terminal and of the battery changing station. Second, several use cases are presented for how the terminal benefits from this forecast.

2:30PM *Fuzzy Power Management for Environmental Monitoring Systems in Tropical Regions [#N-14742]*

Asher G. Watts, Michal Prauzek, Petr Musilek, Emil Pelikan and Arturo Sanchez-Azofeifa, University of Alberta, Canada; Technical University of Ostrava, Czech Republic; Academy of Sciences of the Czech Republic, Czech Republic

Remote environmental monitoring systems require effective energy management to allow their reliable long-term operation without the need for frequent maintenance to replace or recharge batteries. To design and analyze relevant energy management strategies, we have developed Simulink-based models of a recently constructed monitoring device to evaluate its potential performance. The model uses long-term solar energy data from two locations, Chamela, Mexico, and Fairview, Canada, to estimate the energy harvesting capabilities of the device. Using the simulator, we have developed and evaluated a fuzzy energy management strategy that determines how the device should operate to match the solar energy profile in each location. Solar energy in Chamela, Mexico is abundant and consistent so an energy harvesting remote monitoring device could have a high activity level without risking device failure. Fairview, Canada, has limited solar resources in the winter, but plenty in the summer; a device dependent upon this energy source must adapt its activity level to match energy availability, or risk running out of energy. While the simulated device in Mexico outperforms the one in Canada, both succeed in matching the available environmental resources and largely avoid energy related device failure. In the future, their performance can be improved by optimizing the designed strategies and further improving the details of the simulation.

2:50PM *Solar Radiation Forecasting under Asymmetric Cost Functions [#N-14850]*

Seyyed A. Fatemi and Anthony Kuh, University of Hawaii at Manoa, United States

Grid operators are tasked to balance the electric grid such that generation equals load. In recent years renewable energy sources have become more popular since they are both clean and sustainable. Because of intermittency of renewable energy sources like wind and solar, the operators are required to predict renewable generation and allocate some operating reserves to mitigate errors. If they overestimate the renewable generation during scheduling, they do not have enough generation available during operation. So overestimation of resources create a more serious problem than underestimation. However, many researchers who study the solar radiation forecasting problem evaluate their methods using symmetric criteria like root mean square error (RMSE) or mean absolute error (MAE). In this paper, we investigate solar radiation forecasting under LinLin and LinEx which are asymmetric cost functions that are better fitted to the grid operator problem. We formulate the problem as an optimization problem and we used linear programming and steepest descent algorithm to find the solution. Simulation results show substantial cost saving using these methods.

3:10PM *Selection of Weighing Functions in H-infinity Controller Design Using PBIL [#N-14865]*

Prosser Munawa and Komla Folly, University of Cape Town, South Africa

H-infinity optimal control technique is seen as a promising robust control technique that can effectively deal with the problems of model uncertainties. However, for H-infinity optimal control design to be successful one must be able to choose adequate performance and uncertainty weights. Until now, there is no a systematic way of choosing these weighting functions, they are generally selected based on trial and error. This approach not only is ineffective but also time consuming. In this paper, a systematic way of selecting the weighting functions in H-infinity optimal control is proposed. The selection of adequate weighting function is formulated as an optimization problem and solved using Population Based Incremental Learning(PBIL) Algorithm.

Special Session: WeN1-2 International Workshop on Advances in Learning from/with Multiple Learners

Wednesday, July 9, 1:30PM-3:30PM, Room: 305A, Chair: Nistor Grozavu and Guenael Cabanes

1:30PM *Feature Ensemble Learning Based on Sparse Autoencoders for Image Classification [#N-14089]*

Yaping Lu, Li Zhang, Bangjun Wang and Jiwen Yang, Soochow University, China

Deep networks are well known for their powerful function approximations. To train a deep network efficiently, greedy layer-wise pre-training and fine tuning are required. Typically, pre-training, aiming to initialize a deep network, is implemented via unsupervised feature learning, with multiple feature representations generated. However, in general only the last layer representation is to be employed because of its abstraction and compactness being the best with comparisons to the ones of lower layers. To make full use of the representations of all layers, this paper proposes a feature ensemble learning method based on sparse autoencoders for image classification. Specifically, we train three softmax classifiers by using the representations of different layers, instead of one classifier trained by applying the last layer representation. Of the three softmax classifiers, two are obtained by training stacked auto- encoders with fine tuning, and the other one is obtained by directly using a concatenation of two representations. To improve accuracy and stability of a single softmax classifier, the ensemble of multiple classifiers is considered, and some Naive Bayes combination rules are introduced to integrate the three classifiers. Experimental results on the MNIST and COIL datasets are presented, with comparisons to other classification methods.

1:50PM *A Review of Adaptive Feature Extraction and Classification Methods for EEG-Based Brain-Computer Interfaces [#N-14260]*

Shiliang Sun and Jin Zhou, East China Normal University, China

A brain-computer interface (BCI) is a system that allows its users to control external devices which are independent of peripheral nerves and muscles with brain activities. Electroencephalogram (EEG) signals are electrical signals collected from the scalp. They are frequently used in brain-computer interaction. However, EEG signals which change over time are highly non-stationary. One major challenge in current BCI research is how to extract features of time-varying EEG signals and classify the signals as accurately as possible. An effective BCI should be robust against and adaptive to the dynamic variations of brain activities. Adaptive learning in a BCI system, a rapidly developing application of machine learning, would be an effective approach to conquer the challenge. This paper reviews representative adaptive feature extraction and classification methods for EEG- based BCIs and further discusses some important open problems which can hopefully be useful to promote the research of the BCIs.

2:10PM *Diversity Analysis in Collaborative Clustering [#N-14264]*

Nistor Grozavu, Guenael Cabanes and Younes Bennani, Paris 13 University, France

The aim of collaborative clustering is to reveal the common structure of data which are distributed on different sites. The topological collaborative clustering, based on Self-Organizing Maps (SOM) is an unsupervised learning method which is able to use the output of other SOMs from other sites during the learning. This paper investigates the impact of the diversity between collaborators on the collaboration's quality and presents a study of different diversity indexes for collaborative clustering. Based on experiments on artificial and real datasets, we demonstrated that the quality and the diversity of the collaboration can have an important impact on the quality of the collaboration and that not all diversity indexes are relevant for this task.

2:30PM *Solving Unbalanced Problems in Similarity Learning Using SVM Ensemble [#N-14386]*

Peipei Xia and Li Zhang, Soochow Univeristy, China

Similarity learning is one of the most fundamental notions in machine learning and pattern recognition. In real-world problems, the number of the paired-samples in similarity set is far less than the ones in dissimilarity set. In other word, there is an unbalanced problem in the paired-samples of similarity learning. This paper presents a scheme of SVM ensemble to solve it. In our scheme, we randomly select some of samples to construct paired-samples, not producing all the paired-samples, and introduces multiple classifiers to obtain higher stability and reliability. As a result, the SVM ensemble can effectively decrease the number of paired-samples in similarity learning and solve the unbalanced data learning to some degree. In the experiments, the SVM ensemble is compared with some classic unbalanced learning algorithms. The results on classification tasks show that the SVM ensemble gains better performance.

2:50PM *Sharing Information on Extended Reachability Goals Over Propositionally Constrained Multi-Agent State Spaces [#N-14685]*

Anderson Araujo and Carlos Henrique Ribeiro, Instituto Tecnologico de Aeronautica, Brazil

By exchanging propositional constraint information in large state spaces, agents can implicitly reduce the state space, a feature that is particularly attractive for Reinforcement Learning approaches. This paper proposes a learning technique that combines a Reinforcement Learning algorithm and a planner for propositionally constrained state spaces that autonomously help

agents to implicitly reduce the state space towards possible plans that lead to the goal and avoid irrelevant or inadequate states. State space constraints are communicated among the agents using a common constraint set based on extended reachability goals. A performance evaluation against standard Reinforcement Learning techniques showed that by extending autonomous learning with propositional constraints updated along the learning process can produce faster convergence to optimal policies due to early state space reduction caused by shared information on state space constraints.

3:10PM *A New Ensemble Method for Multi-Label Data Stream Classification in Non-Stationary Environment [#N-14744]*

Ge Song and Yunming Ye, Shenzhen Graduate School Harbin Institute of Technology, China

Most existing approaches for the data stream classification focus on single-label data in non-stationary environment. In these methods, each instance can only be tagged with one label. However, in many realistic applications, each instance should be tagged with more than one label. To address the challenge of classifying multi-label stream in evolving environment, we propose a novel Multi-Label Dynamic Ensemble (MLDE) approach. The proposed MLDE integrates a number of Multi-Label Cluster-based Classifiers (MLCCs). MLDE includes an adaptive ensemble method and an ensemble voting method with two important weights, subset accuracy weight and similarity weight. Experimental results reveal that MLDE achieves better performance than state-of-the-art multi-label stream classification algorithms.

3:30PM *An Evaluation of the Environmental Sustainability Index in Terms of Its Prediction and Clustering Capabilities [#N-14909]*

Tatiana Tambouratzis, University of Piraeus, Greece

During the years 1999-2005, the environmental sustainability index (ESI) constituted a predominant tool for evaluating, ranking, and grouping countries in terms of their current and future potential to protect the environment. In this piece of research, an investigation of the calculation/prediction, ranking, and clustering capabilities of the ESI 2005 is performed using traditional as well as computational intelligence tools, the latter including supervised general regression artificial neural networks, probabilistic artificial neural networks, unsupervised self-organizing maps, and fuzzy clustering. The results of the investigation shed some light on the derivation of the ESI, but further research is required for elucidating - and, thus, being able to replicate - the ESI values and clusters.

Special Session: WeN1-3 Machine Learning for Computer Vision I

Wednesday, July 9, 1:30PM-3:30PM, Room: 305B, Chair: Brijesh Verma and Mohammed Bennamoun

1:30PM *Retinal Vessel Segmentation Based on Possibilistic Fuzzy c-means Clustering Optimised with Cuckoo Search [#N-14867]*

Eid Emary, Hossam Zawbaa, Aboul Ella Hassanien, Gerald Schaefer and Ahmad Taher Azar, Cairo University, Egypt; BeniSuef University, Egypt; Loughborough University, United Kingdom; Benha University, Egypt

Automated analysis of retinal vessels is essential for the diagnosis of a wide range of eye diseases and plays an important role in automatic retinal disease screening systems. In this paper, we present an approach to automatic vessel segmentation in retinal images that utilises possibilistic fuzzy c-means (PFCM) clustering to overcome the problems of the conventional fuzzy c-means objective function. In order to obtain optimised clustering results using PFCM, a cuckoo search method is used. The cuckoo search algorithm, which is based on the brood parasitic behaviour of some cuckoo species in combination with the Levy flight behaviour of some birds and fruit flies, is applied to drive the optimisation of the fuzzy clustering. The performance of our algorithm is analysed on two benchmark databases, the DRIVE and STARE datasets, and encouraging segmentation performance is observed.

1:50PM *Large Margin Image Set Representation and Classification [#N-14036]*

Jim Jing-Yan Wang, Majed Alzahrani and Xin Gao, University at Buffalo, The State University of New York, United States; King Abdullah University of Science and Technology, Saudi Arabia

In this paper, we propose a novel image set repre- sentation and classification method by maximizing the margin of image sets. The margin of an image set is defined as the difference of the distance to its nearest image set from different classes and the distance to its nearest image set of the same class. By modeling the image sets by using both their image samples and their affine hull models, and maximizing the margins of the images sets, the image set representation parameter learning problem is formulated as an minimization problem, which is further optimized by an expectation--maximization (EM) strategy with accelerated proximal gradient (APG) optimization in an iterative algorithm. To classify a given test image set, we assign it to the class which could provide the largest margin. Experiments on two applications of video-sequence-based face recognition demonstrate that the proposed method significantly outperforms state-of-the-art image set classification methods in terms of both effectiveness and efficiency.

2:10PM *Improving Machine Vision via Incorporating Expectation-Maximization into Deep Spatio-Temporal Learning [#N-14552]*

Min Jiang, Yulong Ding, Goertzel Ben, Zhongqiang Huang and Fei Chao, Xiamen University, China; Novamente LLC, United States

The Deep Spatio-Temporal Inference Network (DeSTIN) is a deep learning architecture which combines unsupervised learning and Bayesian inference. The original version of DeSTIN incorporates k-means clustering inside each processing node. Here we propose to replace k-means with a more sophisticated algorithm, online EM (Expectation Maximization), and show that this improves DeSTIN's performance on image classification and restoration tasks.

2:30PM *Low-Rank Representation Based Action Recognition [#N-14566]*

Xiangrong Zhang, Yang Yang, Hanghua Jia, Huiyu Zhou and Licheng Jiao, Xidian University, China; Chinese Academy of Sciences, China; Queen's University Belfast, United Kingdom

Human action recognition is an important problem in computer vision, which has been applied to many applications. However, how to learn an accurate and discriminative representation of videos based on the features extracted from videos still remains to be a challenging problem. In this paper, we propose a novel method named low-rank representation based action recognition to recognize human actions. Given a dictionary, low-rank representation aims at finding the lowest-rank representation of all data, which can capture the global data structures. According to its characteristics, low-rank representation is robust against noises. Experimental results demonstrate the effectiveness of the proposed approach on several publicly available datasets.

2:50PM *Interpolating Deep Spatio-Temporal Inference Network Features for Image Classification [#N-14642]*

Yongfeng Zhang, Changjing Shang and Qiang Shen, Aberystwyth University, United Kingdom

This paper presents a novel approach for image classification, by integrating deep machine learning and the concept of feature interpolation. In particular, a recently introduced learning architecture, the Deep Spatio-Temporal Inference Network (DeSTIN) is employed to perform feature extraction for support vector machine (SVM) based image classification. Linear interpolation and Newton polynomial interpolation are each applied to support the classification. This approach converts feature sets of an originally low-dimensionality into those of a significantly higher dimensionality while gaining overall computational simplification. The work is tested against the popular MNIST dataset of handwritten digits. Experimental results indicate that the proposed approach is highly promising.

3:10PM *A Study on Word-Level Multi-Script Identification from Video Frames [#N-14828]*

Nabin Sharma, Umapada Pal and Michael Blumenstein, Griffith University, Australia; Indian Statistical Institute, India

The presence of multiple scripts in multi-lingual document images makes Optical Character Recognition (OCR) of such documents a challenging task. Due to the unavailability of a single OCR system which can handle multiple scripts, script identification becomes an essential step for choosing the appropriate OCR. Although, there are various techniques available for script identification from handwritten and printed documents having simple backgrounds, however script identification from video frames has been seldom explored. Video frames are coloured and suffer from low resolution, blur, complex background and noise to mention a few, which makes the script identification process a challenging task. This paper presents a study of various combinations of features and classifiers to explore whether the traditional script identification techniques can be applied to video frames. A texture based feature namely, Local Binary Pattern (LBP), Gradient based features namely, Histogram of Oriented Gradient (HoG) and Gradient Local Auto-Correlation (GLAC) were used in the study. Combination of the features with SVMs and ANNs where used for classification. Three popular scripts, namely English, Bengali and Hindi were considered in the present study. Due to the inherent problems with the video, a super resolution technique was applied as a pre-processing step. Experiments show that the GLAC feature has performed better than the other features, and an accuracy of 94.25% was achieved when testing on 1271 words from three different scripts. The study also reveals that gradient features are more suitable for script identification than the texture features when using traditional script identification techniques on video frames.

WeN1-4 Intelligent Systems and Applications

Wednesday, July 9, 1:30PM-3:30PM, Room: 305C, Chair: Ivo Bukovsky

1:30PM *B-Spline Neural Network Based Single-Carrier Frequency Domain Equalization for Hammerstein Channels [#N-14012]*

Xia Hong, Sheng Chen and Chris Harris, University of Reading, United Kingdom; University of Southampton, United Kingdom

A practical single-carrier (SC) block transmission with frequency domain equalisation (FDE) system can generally be modelled by the Hammerstein system that includes the nonlinear distortion effects of the high power amplifier (HPA) at transmitter. For such nonlinear Hammerstein channels, the standard SC-FDE scheme no longer works. In this paper, we propose a novel B-spline neural network based nonlinear SC-FDE scheme for Hammerstein channels. In particular, We model the nonlinear HPA, which represents the complex-valued static nonlinearity of the Hammerstein channel, by two real-valued B-spline neural networks, one for modelling the nonlinear amplitude response of the HPA and the other for the nonlinear phase response of the HPA. We then develop an efficient alternating least squares algorithm for estimating the parameters of the Hammerstein channel, including the channel impulse response coefficients and the parameters of the two B-spline models. Moreover, we also use another real-valued B-spline neural network to model the inversion of the HPA's nonlinear amplitude response, and the parameters of this inverting B-spline model can easily be estimated using the standard least squares algorithm based on the pseudo training data obtained as a byproduct of the Hammerstein channel identification. Equalisation of the SC Hammerstein channel can then be accomplished by the usual one-tap linear equalisation in frequency domain as well as the inverse B-spline neural network model obtained in time domain. The effectiveness of our nonlinear SC-FDE scheme for Hammerstein channels is demonstrated in a simulation study.

1:50PM *Coordinated Pattern Tracking of Multiple Marine Surface Vehicles with Uncertain Kinematics and Kinetics [#N-14166]*

Zhouhua Peng, Dan Wang, Hao Wang and Wei Wang, Dalian Maritime University, China

This paper considers the coordinated pattern tracking of multiple marine surface vehicles in the presence of uncertain kinematics and kinetics. Distributed pattern tracking controllers depending on the information of neighboring vehicles are derived based on a backstepping technique, neural networks and an identifier. Specifically, the identifier is devised to precisely estimate the time-varying ocean currents at the kinematic level. Neural networks together with adaptive filtering methods are employed to extract the low frequency content of the model uncertainty and ocean disturbances at the kinetic level. The benefit of the proposed design results in adaptive pattern tracking controllers over any undirected connected graphs with guaranteed low frequency control signals, which facilitates practical implementations. The stability properties of the multi-vehicle systems are established via Lyapunov analysis, and the pattern tracking errors converge to an adjustable neighborhood of origin. An example is given to show the performance of the proposed approach.

2:10PM *A Real-Time Driver Identification System Based on Artificial Neural Networks and Cepstral Analysis [#N-14631]*

Ines del Campo, Raul Finker, Victoria Martinez, Javier Echanobe and Faiyaz Doctor, University of the Basque Country, Spain; Coventry University, United Kingdom

The availability of advanced driver assistance systems (ADAS), for safety and well-being, is becoming increasingly important for avoiding traffic accidents caused by fatigue, stress, or distractions. For this reason, automatic identification of a driver from among a group of various drivers (i.e. real-time driver identification) is a key factor in the development of ADAS, mainly when the driver's comfort and security is also to be taken into account. The main focus of this work is the development of embedded electronic systems for in-vehicle deployment of driver identification models. We developed a hybrid model based on artificial neural networks (ANN), and

cepstral feature extraction techniques, able to recognize the driving style of different drivers. Results obtained show that the system is able to perform real-time driver identification using non-intrusive driving behavior signals such as brake pedal signals and gas pedal signals. The identification of a driver from within groups with a reduced number of drivers yields promising identification rates (e.g. 3-driver group yield 84.6 %). However, real-time development of ADAS requires very fast electronic systems. To this end, an FPGA-based hardware coprocessor for acceleration of the neural classifier has been developed. The coprocessor core is able to compute the whole ANN in less than 4 microseconds.

2:30PM *An Approach to Exploit Non-Optimized Data for Efficient Control of Unknown Systems through Neural and Kernel Models [#N-14671]*

Cristiano Cervellera, Mauro Gaggero, Danilo Maccio and Roberto Marcialis, Institute of Intelligent Systems for Automation, National Research Council, Italy

In this paper, efficient real time control strategies are devised for systems with unknown state equation, based only on a set of data inherited from non-optimized, possibly inefficient, operation of the system, in the case in which experimenting online with the latter is impossible or costly. Neural networks and kernel smoothing models are employed as architectures for learning the system dynamics. The former require an offline training phase to learn the state equation, whereas the latter exploit the available data in a direct fashion, thus making the proposed approach directly applicable online and able to exploit new available data without the need of an offline training. Convergence properties of the proposed algorithm for generating the control strategies are provided under suitable hypotheses. Simulation results on classic benchmark systems are reported for performance evaluation, also through a comparison with the SARSA reinforcement learning algorithm.

2:50PM *Neural Network Approach to Hoist Deceleration Control [#N-14724]*

Peter Benes and Ivo Bukovsky, Czech Technical University in Prague, Czech Republic

This paper introduces a neural network approach to hoist deceleration control of industrial hoist mechanisms, with particular focus to crane applications. The necessity for investigation in this field arises from the increasing demands in terms of safety within in the industry. This paper analyses the potentials of hoist deceleration control by neural network architectures as such the linear, quadratic and cubic neural units with real-time recurrent learning and back-propagation through time approach when real measured data are used for experimental analysis.

WeN1-5 Unsupervised Learning and Clustering I

Wednesday, July 9, 1:30PM-3:30PM, Room: 305D, Chair: Fuchun Sun

1:30PM *A Locally Adaptive Boundary Evolution Algorithm for Novelty Detection Using Level Set Methods [#N-14066]*

Xuemei Ding, Yuhua Li, Ammar Belatreche and Liam Maguire, Fujian Normal University, China; University of Ulster, United Kingdom

This paper proposes a new locally adaptive boundary evolution algorithm for level set methods (LSM)-based novelty detection. The proposed approach consists of level set function construction, boundary evolution, and evolution termination. It utilises the exterior data points lying outside the decision boundary to effect the segments of the boundary that need to be locally evolved in order to make the boundary better fit the data distribution, so it can evolve boundary locally without requiring knowing explicitly the decision boundary. The experimental results demonstrate that the proposed approach can effectively detect novel events as compared to the reported LSM-based novelty detection method with global boundary evolution scheme and four representative novelty detection methods when there is an exacting error requirement on normal events.

1:50PM *Tensor LRR Based Subspace Clustering [#N-14169]*

Yifan Fu, Junbin Gao, David Tien and Zhouchen Lin, Charles Sturt University, Australia; Peking University, China

Subspace clustering groups a set of samples (vectors) into clusters by approximating this set with a mixture of several linear subspaces, so that the samples in the same cluster are drawn from the same linear subspace. In majority of existing works on subspace clustering, samples are simply regarded as being independent and identically distributed, that is, arbitrarily ordering samples when necessary. However, this setting ignores sample correlations in their original spatial structure. To address this issue, we propose a tensor lowrank representation (TLRR) for subspace clustering by keeping available spatial information of data. TLRR seeks a lowestrank representation over all the candidates while maintaining the inherent spatial structures among samples, and the affinity matrix used for spectral clustering is built from the combination of similarities along all data spatial directions. TLRR better captures the global structures of data and provides a robust subspace segmentation from corrupted data. Experimental results on both synthetic and real-world datasets show that TLRR outperforms several established state-of-the-art methods.

2:10PM *A Kernel K-Means Clustering Algorithm Based on an Adaptive Mahalanobis Kernel [#N-14447]*

Marcelo Ferreira and Francisco De Carvalho, Federal University of Paraiba, Brazil; Federal University of Pernambuco, Brazil

In this paper, a kernel K-means algorithm based on an adaptive Mahalanobis kernel is proposed. This kernel is built based on an adaptive quadratic distance defined by a symmetric positive definite matrix that changes at each algorithm iteration and takes into account the correlations between variables, allowing the discovery of clusters with non-hyperspherical shapes. The effectiveness of the proposed algorithm is demonstrated through experiments with synthetic and benchmark datasets.

2:30PM *A New Distance Metric for Unsupervised Learning of Categorical Data [#N-14804]*

Hong Jia and Yiu-ming Cheung, Hong Kong Baptist University, Hong Kong

Distance metric is the basis of many learning algorithms and its effectiveness usually has significant influence on the learning results. Generally, measuring distance for numerical data is a tractable task, but for categorical data sets, it could be a nontrivial problem. This paper therefore presents a new distance metric for categorical data based on the characteristics of categorical values. Specifically, the distance between two values from one attribute measured by this metric is determined by both of the frequency probabilities of these two values and the values of other attributes which have high interdependency with the calculated one. Promising experimental results on different real data sets have shown the effectiveness of proposed distance metric.

2:50PM *Box-Constrained Projective Nonnegative Matrix Factorization via Augmented Lagrangian Method [#N-14861]*

Xiang Zhang, Naiyang Guan, Long Lan, Dacheng Tao and Zhigang Luo, National University of Defense Technology, China; University of Technology Sydney, Australia

Projective non-negative matrix factorization (PNMF) projects a set of examples onto a subspace spanned by a non-negative basis whose transpose is regarded as the projection matrix. Since PNMF learns a natural parts-based representation, it has been successfully used in text mining and pattern recognition. However, it is non-trivial to analyze the convergence of the optimization algorithms for PNMF because its objective function is non-convex. In this paper, we propose a Box-constrained PNMF (BPNMF) method to overcome this deficiency of PNMF. In particular, BPNMF introduces an auxiliary variable, i.e., the coefficients of examples, and incorporates the following two types of constraints: 1) each entry of the basis is non-negative and upper-bounded, i.e., box-constrained, and 2) the coefficients equal to the projected points of the examples. The first box constraint makes the basis to be bound and the second equality constraint keeps its equivalence to PNMF. Similar to PNMF, BPNMF is difficult because the objective function is non-convex. To solve BPNMF, we developed an efficient algorithm in the frame of augmented Lagrangian multiplier (ALM) method and proved that the ALM-based algorithm converges to local minima. Experimental results on two face image datasets demonstrate the effectiveness of BPNMF compared with the representative methods.

3:10PM *A Survey of Distance / Similarity Measures For Categorical Data [#N-14889]*

Madhavi Alamuri, Bapi Raju Surampudi and Atul Negi, University Of Hyderabad, India; University of Hyderabad, India

Similarity or distance between two objects plays a fundamental role in many data mining tasks like classification and clustering. Categorical data, unlike numeric data, conceptually is deficient of default ordering relations on the attribute values. This makes the task of devising similarity or distance metrics and data mining tasks such as classification and clustering of categorical data more challenging. In this paper we formulate a taxonomy of various distance or similarity measures used in conjunction with data whose attributes are categorical. We categorize the existing measures into two broad classes, namely, Context-free and Context-sensitive measures for categorical data. In addition, we suggest a taxonomy of the clustering approaches for categorical data. We also propose a hybrid approach for measuring similarity between objects. We make a relative comparison of the strengths and weaknesses of some of the similarity measures and point out future research directions.

WeN1-6 Supervised and Semi-Supervised Learning

Wednesday, July 9, 1:30PM-3:30PM, Room: 305E, Chair: Marley Vellasco

1:30PM *Lattice Sampling for Efficient Learning with Nadaraya-Watson Local Models [#N-14610]*

Cristiano Cervellera, Mauro Gaggero, Danilo Maccio and Roberto Marcialis, Institute of Intelligent Systems for Automation, National Research Council, Italy

The classical machine learning problem of estimating an unknown function through an empirical risk minimization (ERM) procedure is addressed when models based on local evaluation of the output are employed and there is freedom to sample the input space according to some deterministic rule. The combined use of lattice point sets, commonly employed for numerical integration, and local models based on kernel smoothers of the Nadaraya-Watson kind are analyzed regarding consistency of the ERM procedure. It is proved that the regular structure of lattice sampling guarantees the latter with good convergence rates. Furthermore, it is shown how the regular structure allows also practical advantages, like fast computation of the model output. Simulation tests are presented to showcase the behavior of Nadaraya-Watson models with lattice sampling in various function learning problems.

1:50PM *Trimmed Affine Projection Algorithms [#N-14597]*

Badong Chen, Xiaohan Yang, Hong Ji, Hua Qu, Nanning Zheng and Jose Principe, Xi'an Jiaotong University, China; University of Florida, United States

The least trimmed squares (LTS) estimator is a robust estimator as it can avoid undue influence from outliers. The exact solution of the LTS estimation is however hard to find and if the number of data is large then the method is unfeasible. In this work, we apply the LTS criterion to adaptive filtering and develop the trimmed affine projection algorithm (TAPA) and kernel trimmed affine projection algorithm (KTAPA). The proposed adaptive algorithms are very robust to outliers and have low computational complexity. Simulation results confirm their excellent and robust performance.

2:10PM *Reconstructable Generalized Maximum Scatter Difference Discriminant Analysis [#N-14196]*

Kai Huang and Liqing Zhang, Shanghai Jiao Tong University's Department of Computer Science and Engineering, China

Dimensionality reduction is a key preprocessing step for many applications. Until our knowledge, unsupervised approaches such as PCA and ICA do not take label information of the original data into account, so a supervised approach such as Linear discriminant analysis (LDA) performs better on many classification tasks. Unfortunately, the classical LDA approach has shortcomings, such as the well-known \emph{small size problem}, the \emph{heteroscedastic problem} and the \emph{(C-1) low rank problem}. The (C-1) low rank problem greatly limits the dimension of the extracted features. In addition, the calculation of the between-class and within-class scatter matrices in the classical LDA approach actually only takes account of the Mahalanobis distance like covariance distance of data centers and each data class, so if the dataset has very few classes or the data distribution of each class is not Gaussian-like but has some spatial structure in the feature space instead, classical LDA does not work well. In this paper we propose a dimensionality reduction approach which avoids the limitations of classical LDA and improves handling of the between-class scatter matrix. Our approach approach takes the distribution of data in each class into consideration to calculate the projection matrix. It does not assume that the data distribution of each class approximates Gaussian; each can have its own spatial structure. Experiments show that our method can obtain better projection directions than the classical LDA approach and greatly improve the classification accuracy. In addition, our approach is able to reconstruct the original signal well, while the classical LDA approach ignores the reconstruction property.

2:30PM *Music Genre Classification Using On-Line Dictionary Learning [#N-14243]*

M. Srinivas, Debaditya Roy and C. Krishna Mohan, Indian Institute of Technology Hyderabad, India

In this paper, an approach for music genre classification based on sparse representation using MARSYAS features is proposed. The MARSYAS feature descriptor consisting of timbral texture, pitch and beat related features is used for the classification of music genre. On-line Dictionary Learning

(ODL) is used to achieve sparse representation of the features for developing dictionaries for each musical genre. We demonstrate the efficacy of the proposed framework on the Latin Music Database (LMD) consisting of over 3000 tracks spanning 10 genres namely Axe, Bachata, Bolero, Forro, Gaucha, Merengue, Pagode, Salsa, Sertaneja and Tango.

2:50PM *Semi-Supervised Local-Learning-Based Feature Selection [#N-14356]*

Jim Jing-Yan Wang, Jin Yao and Yijun Sun, The State University of New York, United States

Local-learning-based feature selection has been successfully applied to high-dimensional data analysis. It utilizes class labels to define a margin for each data sample and selects the most discriminative features by maximizing the margins with regard to a feature weight vector. However, it requires that all data samples are labeled, which makes it unsuitable for semi-supervised learning where only a handful of training samples are labeled while most are unlabeled. To address this issue, we herein propose a new semi- supervised local-learning based feature selection method. The basic idea is to learn the class labels of unlabeled samples in a new feature subspace induced by the learned feature weights, and then use the learned class labels to define the margins for feature weight learning. By constructing and optimizing a unified objective function, the feature weights and class labels are learned simultaneously in an iterative algorithm. The experiments performed on some benchmark data sets show the advantage of the proposed algorithm over stat-of-the-art semi-supervised feature selection methods.

Industrial Session: WeN1-7 CI on Control Systems

Wednesday, July 9, 1:30PM-3:30PM, Room: 303, Chair: Ruben Morales-Menendez and Aguilar Jose

1:30PM *Experimental ANN-Based Modeling of an Adjustable Damper [#N-14056]*

Juan Carlos Tudon-Martinez, Ruben Morales-Menendez, Ricardo A Ramirez-Mendoza and Luis E Garza-Castanon, Tecnologico de Monterrey, Mexico

A model for a Magneto-Rheological (MR) damper based on Artificial Neural Networks (ANN) is proposed. The design of the ANN model is focused to get the best architecture that manages the trade-off between computing cost and performance. Experimental data provided from two commercial MR dampers with different properties have been used to validate the performance of the proposed ANN model in comparison with the classical parametric model of Bingham. Based on the Root Mean Square Error index, an average error of 7.2 % is obtained by the ANN model, by taking into account 5 experiments with 10 replicas each one; while the Bingham model has 13.8 % of error.

1:50PM *Scaling-Up Action Learning Neuro-Controllers with GPUs [#N-14856]*

Martin Peniak and Angelo Cangelosi, Plymouth University, United Kingdom

Neural networks have been used in many different robot motor-control experiments, however, so far the complexity of these neuro-controllers have remained at the similar level. The focus of this paper is to demonstrate that it is possible to scale-up these neuro-robotic controllers with GPUs leading to richer, more realistic and more complex motor control.

2:10PM *Application of Genetic Algorithms to Neural Networks Based Control of a Liquid Level Tank System [#N-14840]*

Kristina Vassiljeva, Juri Belikov and Eduard Petlenkov, Tallinn University of Technology, Estonia; Institute of Cybernetics, Tallinn University of Technology, Estonia

In this paper, a design of a controller based on the NN-SANARX (Neural Network based Simplified Additive Autoregressive eXogenous) model is considered on the basis of a prototype of a real liquid level tank system. Structure of the neural network is chosen using two different methods of genetic algorithms with multi- objective optimization. The goal of the control algorithm is to track the desired level of the liquid in the upper tank.

2:30PM *Hybrid Intelligent Supervision Model of Oil Wells [#F-14301]*

Edgar Camargo and Aguilar Jose, Petroleos de Venezuela, S.A., Venezuela; Universidad de Los Andes, Venezuela

In this work is presented a hybrid intelligent model based on Evolutionary Computation and Fuzzy Systems to improve the performance of the Oil Industry, which is used for Operational Diagnosis in petroleum wells that require gas lift (GL). The model is used for an optimization problem where the objective function is composed by two criteria: maximization of the production of oil and minimization of the flow of gas injection, based on the restrictions of the process and the operational cost of production. We use the genetic algorithms to solve this problem, and the fuzzy logic to identify the operational scenarios in an oil well. In this way, our hybrid intelligent model implements supervision and control tasks

2:50PM *Fuzzy Adaptive Cruise Control System with Speed Sign Detection Capability [#F-14335]*

Raazi Rizvi, Shivam Kalra, Chirag Gosalia and Rahnamayan Shahryar, University of Ontario Institute of Technology, Canada; IBM Toronto Laboratory, Canada; RSI, Canada

Advanced Driver Assistance System (ADAS) is one of latest innovations in the auto- mobile industry and has become a premium feature in many luxury vehicles. ADAS assists drivers by integrating multiple safety and convenience features into a single system. Current ADAS technology usually comprises of an Adaptive Cruise Control (ACC) system in combination with one or more warning/prevention systems. Such as lane departure, collision avoidance, and parking assist systems. This paper outlines a fuzzy logic based ADAS with integrated speed sign detection (SSD) capability. The described system improves safety of the vehicle by dynamically adjusting the speed of the ACC in accordance with the speed limit of the road. The proposed ADAS system will be helpful in reducing speeding violations and enhancing smoother cruise control in heavy traffic conditions. All system design, implementation and testing was done using the MATLAB development environment, and TORCS virtual car simulator.

3:10PM *Soft Computing Techniques Based Optimal Tuning of Virtual Feedback PID Controller for Chemical Tank Reactor [#E-14814]*

Manikandan Pandiyan, PSG College of Technology, India

CSTR plays a vital role in almost all the chemical reactions and is a highly nonlinear system exhibiting stable as well as unstable steady states. The variables which characterize the quality of the final product in CSTR are often difficult to measure in real-time and cannot be directly measured using the feedback configuration. So, a virtual feedback control is implemented to control the state variables using Extended Kalman Filter (EKF) in the feedback path. Since it is hard to determine the optimal or near optimal PID parameters using classical tuning techniques like Ziegler Nichols method, a highly skilled optimization algorithm like Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO) are used. This work is based on the optimal tuning of virtual feedback PID control for a CSTR system using soft computing algorithm for minimum Integral Square Error (ISE) condition.

WeI1-1 Intel Special Session on Big Data Analytics

Wednesday, July 9, 1:30PM-3:30PM, Room: 311A, Chair: Catherine Huang

1:30PM *Practice in Analyzing Corporate Textual Data*

Phil Tian, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

1:50PM *Intel Hadoop and Its Use Cases*

Keith Qi, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:10PM *Big Data Foundation Platform for Video Analytics*

Albert Hu, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:30PM *Cloud based Air Quality Monitoring at Scale*

Fred Jiang, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:50PM *Big Data Foundation Platform for Video Analytics Demo*

Albert Hu, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

3:10PM *Cloud based Air Quality Monitoring at Scale Demo*

Fred Jiang, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

Wednesday, July 9, 3:30PM-6:00PM

Poster Session: PN3 Poster Session 3

Wednesday, July 9, 3:30PM-6:00PM, Room: Posters Area (Level 3), Chair: Manuel Roveri

P501 *An Implementation of the Path Integrator Mechanism of Head Direction Cells for Bio-Mimetic Navigation [#N-14620]*

Ankur Sinha and Jack Wang, University of Technology, Sydney, Australia

Head direction cells are thought to be an integral part of the neural navigation system. These cells track the agent's current head direction irrespective of the host's location. In doing so, they process a combination of inputs: angular velocity and visual inputs are major effectors; to correctly encode the agent's current heading. There are close to fifteen models of head direction cell systems found in literature today. Very few of these models have been implemented for bio-mimetic navigation in robots. In this paper, we describe an implementation of the head direction cell system on the ROS robotic platform as a first step towards a bio-mimetic navigation system for the PR2 robot.

P502 *A Legged Central Pattern Generation Model for Autonomous Gait Transition. [#N-14646]*

Zhijun Yang, Rocha Marlon, Lima Priscila, Karamanoglu Mehmet and Franca Felipe, Middlesex University, United Kingdom; Federal University of Rio de Janeiro, Brazil; MIddlesex University, United Kingdom

In this work, a generalized central pattern generator (CPG) model is formulated to generate a full range of gait patterns for a hexapod insect. To this end, a recurrent neural network module, as the building block for rhythmic patterns, is proposed to extend the concept of oscillatory building blocks (OBB) for constructing a CPG model. The model is able to make transitions between different gait patterns by simply adjusting one model parameter. Simulation results are further presented to show the effectiveness and performance of the CPG network.

P503 *An Algorithm for Real-Time Object Tracking in Complex Environment [#N-14662]*

Dongxu Gao, Jiangtao Cao and Zhaojie Ju, Liaoning Shihua University, China; University of Portsmouth, England

The current sparse representation tracking algorithm is not suitable for the objects that illumination changes, scale changes, the object color is similar with the surrounding region,and occlusion etc, what's more, it is hard to realize real-time tracking for solving an l1 norm related minimization problems. An optimal algorithm is introduced by exploiting an accelerated proximal gradient approach which contains some improvements of particle filter function, sparse representation alterative weights and coefficient. These improvements not only reduce the influences of appearance change but also make the tracker runs in real time. Both qualitative and quantitative evaluations demonstrate that the proposed tracking algorithm has favorably better performance than several state-of-the-art trackers using challenging benchmark image sequences, and significantly reduces the computing cost.

P504 *Robust Prediction in Nearly Periodic Time Series Using Motifs [#N-14674]*

Woon Huei Chai, Hongliang Guo and Shen-Shyang Ho, Nanyang Technological University, Singapore

In this paper, we consider the prediction task for a process with nearly periodic property, i.e., patterns occur with some regularities but no exact periodicity. We propose an inference approach based on probabilistic Markov framework utilizing motif-driven transition probabilities for sequential prediction. In particular, a Markov-based weighting framework utilizing fully the information from recent historical data and sequential pattern regularities is developed for nearly periodic time series prediction. Preliminary experimental results show that our prediction approach is competitive against the moving average approach on synthetic data. Moreover, our proposed method is shown to be empirically robust on time-series with missing data

and noise. We also demonstrate the usefulness of our proposed approach on a real-world vehicle parking lot availability prediction task.

P505 *A Hybrid Coupled k-Nearest Neighbor Algorithm on Imbalance Data [#N-14676]*

Chunming Liu, Longbing Cao and Philip S Yu, University of Sydney Technology, Australia; University of Illinois at Chicago, United States

The state-of-the-art classification algorithms rarely consider the relationship between the attributes in the data sets and assume the attributes are independently to each other (IID). However, in real-world data, these attributes are more or less interacted via explicit or implicit relationships. Although the classifiers for class-balanced data are relatively well developed, the classification of class-imbalanced data is not straightforward, especially for mixed type data which has both categorical and numerical features. Limited research has been conducted on the class-imbalanced data. Some algorithms mainly synthesize or remove instances to force the sizes of each class comparable, which may change the inherent data structure or introduces noise to the source data. While for the distance or similarity based algorithms, they ignored the relationship between features when computing the similarity. This paper proposes a hybrid coupled k-nearest neighbor classification algorithm (HC-kNN) for mixed type data, by doing discretization on numerical features to adapt the inter coupling similarity as we do on categorical features, then combing this coupled similarity to the original similarity or distance, to overcome the shortcoming of the previous algorithms. The experiment results demonstrate that our proposed algorithm can get a higher average performance than that of the relevant algorithms (e.g. the variants of kNN, Decision Tree, SMOTE and NaiveBayes).

P506 *A Consensus-Based Semi-Supervised Growing Neural Gas [#N-14699]*

Vinicius Maximo, Marcos Quiles and Maria Nascimento, Federal University of Sao Paulo, Brazil

In this paper, we propose a new semi-supervised growing neural gas (GNG) model, named Consensus- Based Semi-Supervised GNG, or CSSGNG, in which both labeled and unlabeled data are used to train the network. In contrast to former adaptations of the GNG to semi-supervised classification, such as the SSGNG and OSSGNG models, the CSSGNG does not assign a single scalar label value to each neuron. Instead of the scalar, a vector containing the representativeness level of every class is associated with each neuron. Moreover, to propagate the labels among the neurons the CSSGNG employs a consensus approach. Computer experiments show that our model on average can deliver better classification results in comparison to the SSGNG and OSSGNG models.

P507 *Bio-Inspired Architecture for a Reactive-Deliberative Robot Controller [#N-14701]*

Fabian Rubilar, Maria-Jose Escobar and Tomas Arredondo, Universidad Tecnica Federico Santa Maria, Chile

An incremental, bio-inspired control architecture for robots is proposed. The architecture is composed of two layers where each layer is intended to react in an analogous way to how our brain reacts to external and internal stimuli, using instinctive or deliberative reactions. The first layer, the Drive/Emotional Controller (DE Controller), uses Action Programs which are instinctual, low-level responses to a certain external stimuli. The second layer, the Deliberative/Reflective Controller (DR Controller), can only react to changes in the internal state of the DE controller. Memory, self-reflection, feelings and imagination are some of the concepts that could be considered by the DR Controller architecture, which is intended to generate high-level conscious reactions. These controllers integrate emotions into standard behavior- based architectures. We tested the proposed architecture in a task of free exploration using MODI, a two- wheeled mobile robot. Two DR controllers are tested in three different scenarios validating the proposed architecture in robotic applications.

P508 *Improved Keyword Spotting System by Optimizing Posterior Confidence Measure Vector Using Feed-Forward Neural Network [#N-14715]*

Yuchen Liu, Mingxing Xu and Lianhong Cai, Tsinghua University, China

In this paper, a novel method based on feed-forward neural network is proposed to optimize the confidence measure for improving a mandarine keyword spotting system. Keyword spotting is to detect the occurrences of a pre-defined list of keywords in the input speech, and confidence measure is an critical part in the verification stage of keyword spotting. Posterior confidence has been widely used and was verified to be effective. In some previous works, the optimization of posterior confidence has been proposed, which linearly transforms the phone-level confidence into the word-level confidence. On this basis, we propose a neural network based method that make a non-linear transformation. In addition, a sparse activation and back-propagation strategy is proposed to make this method feasible and work fast. In the experiments, the proposed method is compared to other two previous methods. To evaluate performance, two most commonly used measures are considered: AUC and EER. The experimental result shows that the proposed method is effective and achieved the best performance among three methods.

P509 *Agglomerative Clustering of Defects in Ultrasonic Non-Destructive Testing Using Hierarchical Mixtures of Independent Component Analyzers [#N-14718]*

Addisson Salazar, Jorge Igual and Luis Vergara, Universidad Politecnica Valencia, Spain

This paper presents a novel procedure to classify materials with different defects, such as holes or cracks, from mixtures of independent component analyzers. The data correspond to the ultrasonic echo recorded after an impact by several sensors on the surface of the material. These signals are modelled by independent component analysis mixture models (ICAMM) for every kind of defect. After the ICAMM model is estimated for every defect, these are merged according to a distance measure that is obtained from the Kullback-Leibler divergence. The hierarchy obtained from the impact-echo data and the learning process allow different kinds of defective materials to be grouped consistently.

P510 *Completed Hybrid Local Binary Pattern for Texture Classification [#N-14751]*

Jing-Hua Yuan, Hao-Dong Zhu, Yong Gan and De-Shuang Huang, Tongji University, China; Zhengzhou University of Light Industry, China

Texture classification is an active research topic in pattern recognition and computer vision and has been used in many applications, such as remote sensing, biomedical image analysis, face detection face recognition, and image recognition and retrieval. Generally, texture images captured in the real world may have obvious orientation variations. Therefore, Rotation invariant texture analysis is immensely needed from both the theoretical and practical viewpoint. As one of the representative algorithms for texture classification, LBP (Local Binary Pattern) has made a success since it was proposed. In the past years, many variants of LBP has been presented to improve LBP. For example, CLBP (Completed LBP), derived from LBP, outperforms LBP. In order to make LBP less sensitive to illumination variations and view-point variations, we try to propose a more stable and robust framework of LBP by exploiting more detailed discriminative information. In this paper, we first propose an Order-based Center-Symmetric Loacal Binary Pattern (OCS-LBP) to capture high order information in the local region, and then we introduce the Hybird Local Binary Pattern (HLBP) based on LBP and OCS-LBP. Finally, we present a hybrid framework of LBP (Completed Hybrid Local Binary Pattern) based on the original LBP and OCS-LBP. In addition, we also introduce an Average Local Gray Level (ALG) strategy to enhance CHLBP. The results obtained from two representative texture databases show that the proposed method is robust to illuminant variations and view-point variations and achieve impressive classification accuracy.

P511 *Pitch Estimation Using Non-Negative Matrix Factorization [#N-14773]*

Ryan Burt, Goktug Cinar and Jose Principe, University of Florida, United States; Univeristy of Florida, United States

The problem of pitch detection consists of estimating the dominant frequency present in a certain time window. This paper demonstrates and analyzes the use of a non-negative matrix factorization technique with a frequency basis formed with a correntropy kernel. This offers the advantage that the frequency basis is adaptable, allowing the matrix factorization to fit the data precisely, as well as including a dictionary specifically to account for noise. Using non-negative matrix factorization also allows an increase in dimensionality, which increases the frequency resolution of the algorithm. The method is tested on a database of trumpet notes and compared to other current methods, improving on their performance for noisy signals.

P512 *On the Dynamics of the High Order Type of Neural Networks with Time Varying Coefficients and Mixed Delay [#N-14778]*

Hajer Brahmi, Boudour Ammar, Farouk Cherif and Adel M. Alimi, University of Sfax, Tunisia; University of Sousse Tunisia, Tunisia

This paper discuss the oscillations of high-Order type recurrent delayed neural networks. Various creteria are used to prove the existence and uniqueness of such solutions in a suitable convex domain. Besides, several approaches are applied to establish sufficient condition for the globally exponential stability of this system. Our method is based on constructing suitable Lyapunov functionals and the well-known Banach contraction mapping principle.

P513 *DL-Pro: A Novel Deep Learning Method for Protein Model Quality Assessment [#N-14805]*

Son Nguyen, Yi Shang and Dong Xu, University of Missouri, United States

Computational protein structure prediction is very important for many applications in bioinformatics. In the process of predicting protein structures, it is essential to accurately assess the quality of generated models. Although many single-model quality assessment (QA) methods have been developed, their accuracy is not high enough for most real applications. In this paper, a new approach based on C-alpha atoms distance matrix and machine learning methods is proposed for single-model QA and the identification of native-like models. Different from existing energy/scoring functions and consensus approaches, this new approach is purely geometry based. Furthermore, a novel algorithm based on deep learning techniques, called DL-Pro, is proposed. For a protein model, DL-Pro uses its distance matrix that contains pairwise distances between two residues' C-alpha atoms in the model, which sometimes is also called contact map, as an orientation-independent representation. From training examples of distance matrices corresponding to good and bad models, DL-Pro learns a stacked autoencoder network as a classifier. In experiments on selected targets from the Critical Assessment of Structure Prediction (CASP) competition, DL-Pro obtained promising results, outperforming state-of-the-art energy/scoring functions, including OPUS-CA, DOPE, DFIRE, and RW.

P514 *Mimicking the Worm - An Adaptive Spiking Neural Circuit for Contour Tracking Inspired by C. Elegans Thermotaxis [#N-14807]*

Ashish Bora, Arjun Rao and Bipin Rajendran, Indian Institute of Technology Bombay, India

We demonstrate a spiking neural circuit with timing-dependent adaptive synapses to track contours in a two-dimensional plane. Our model is inspired by the architecture of the 7-neuron network believed to control the thermotaxis behavior in the nematode Caenorhabditis Elegans. However, unlike the C. Elegans network, our sensory neuron only uses the local variable and not its derivative to implement contour tracking, thereby minimizing the complexity of implementation. We employ spike timing based adaptation and plasticity rules to design micro- circuits for gradient detection and tracking. Simulations show that our bio- mimetic neural circuit can identify isotherms with approximately 60 percent higher probability than the theoretically optimal memoryless Levy foraging model. Further, once the set-point is identified, our model's tracking accuracy is in the range of 0.05 degree Celsius, similar to that observed in nature. The neurons in our circuit spike at sparse biological rates, enabling energy-efficient implementations.

P515 *Neural Approach for Bearing Fault Classification in Induction Motors by Using Motor Current and Voltage [#N-14466]*

W. F. Godoy, I. N. da Silva, A. Goedtel, R. H. C. Palacios and W. S. Gongora, University of Sao Paulo, Brazil; Federal Technological University of Parana, Brazil; Parana Federal Institute of Education, Science and Technology, Brazil

The induction motor is considered one of the most important elements in manufacturing processes. The use of strategies based on intelligent systems capable to classify the presence or absence of failures and also to determine its origin for the diagnosis and faults prediction is widely investigated in three phase induction motors. Thus, the aim of this paper is to present a methodology of bearing failures classification based on artificial neural networks, by using voltage and electric currents values in the time domain. Experimental results collected at real industrial process are presented to validate this proposal.

P516 *Efficient Class Incremental Learning for Multi-Label Classification of Evolving Data Streams [#N-14857]*

Zhongwei Shi, Yimin Wen and Yun Xue, Guilin University of Electronic Technology, China; Hunan City University, China

Multi-label stream classification has not been fully explored for the unique properties of large data volumes, real-time, label dependencies, etc. Some methods try to take into account label dependencies, but they only focus on the existing frequent label combinations, leading to worse performance for multi- label classification. To deal with these problems, this paper proposes an algorithm which dynamically recognizes some new frequent label combinations and updates the trained classifier by class incremental learning strategy. Experimental results over both real-world and synthetic datasets demonstrate its better predictive performance

P517 *Probabilistic Point Set Matching with Gaussian Mixture Model [#N-14860]*

Han-Bing Qu and Jia-Qiang Wang, Beijing Academy of Science and Technology, China

In this work, we propose a variational approximation approach in combination with isotropic Gaussian mixtures with regard to each individual transformed points for point set matching problems. A variational inference algorithm is formulated to update the posteriors of the random variables in sequence until a local optimum is reached. The probabilistic framework explicitly accounts for matching uncertainty and is thus less prone to local optima. Furthermore, the Gaussian mixtures with anisotropic covariance are also proposed for the modeling of spurious points instead of the one uniform distribution. The experimental results show that the combination of variational approximation with mixture model provides our algorithm with comparable performance of accuracy and robustness to other registration algorithms in the presence of outliers.

P518 *EEG Analysis for Cognitive Failure Detection in Driving Using Neuro-Evolutionary Synergism [#N-14863]*

Anuradha Saha, Amit Konar, Ritambhar Burman and Atulya Nagar, Jadavpur University, India; Liverpool Hope University, India

The paper proposes a solution to reduce accidents in driving by alarming specific cognitive failures to the drivers on occurrence of the failures. Three different types of cognitive failures that might occur due to lapse of i) visual alertness, ii) cognitive planning and iii) motor execution are studied, and suitable classifiers have been employed to classify these failures. Force exerted by the driver during turning or sudden tracking is also measured to detect his level of cognitive load during significant changes in the driving environment. Recurrent neural networks are introduced here as classifiers to decode cognitive tasks performed by the driver from his acquired EEG. For each recurrent neural net, we use a Lyapunov energy surface the minima of which denote the cognitive tasks during one of three cognitive activities mentioned above. Given the features of the measured EEG for a cognitive tasks, the recurrent net converges to one of several optima, describing a specific cognitive failure. Experimental results obtained by employing a driving simulator and an EEG system are encouraging.

P519 *Multi-Objective Optimization of a Hybrid Model for Network Traffic Classification by Combining Machine Learning Techniques [#N-14877]*

Zuleika Nascimento, Djamel Sadok, Stenio Fernandes and Judith Kelner, Federal University of Pernambuco, Brazil

Considerable effort has been made by researchers in the area of network traffic classification, since the Internet is constantly changing. This characteristic makes the task of traffic identification not a straightforward process. Besides that, encrypted data is being widely used by applications and protocols. There are several methods for classifying network traffic such as known ports and Deep Packet Inspection (DPI), but they are not effective since many applications constantly randomize their ports and the payload could be encrypted. This paper proposes a hybrid model that makes use of a classifier based on computational intelligence, the Extreme Learning Machine (ELM), along with Feature Selection (FS) and Multiobjective Genetic Algorithms (MOGA) to classify computer network traffic without making use of the payload or port information. The proposed model presented good results when evaluated against the UNIBS data set, using four performance metrics: Recall, Precision, Flow Accuracy and Byte Accuracy, with most rates exceeding 90%. Besides that, presented the best features and feature selection algorithm for the given problem along with the best ELM parameters.

P520 *Learning Motion-Difference Features Using Gaussian Restricted Boltzmann Machines for Efficient Human Action Recognition [#N-14896]*

Tran Son, Benetos Emmanouil and Garcez Artur, City University London, United Kingdom

Learning visual words from video frames is challenging because deciding which word to assign to each subset of frames is a difficult task. For example, two similar frames may have different meanings in describing human actions such as starting to run and starting to walk. In order to associate richer information to vector-quantization and generate visual words, several approaches have been proposed recently that use complex algorithms to extract or learn spatio- temporal features from 3-D volumes of video frames. In this paper, we propose an efficient method to use Gaussian RBM for learning motion-difference features from actions in videos. The difference between two video frames is defined by a subtraction function of one frame by another that preserves positive and negative changes, thus creating a simple spatio-temporal saliency map for an action. This subtraction function removes, by construction, the common shapes and background images that should not be relevant for action learning and recognition, and highlights the movement patterns in space, making it easier to learn the actions from such saliency maps using shallow feature learning models such as RBMs. In the experiments reported in this paper, we used a Gaussian restricted Boltzmann machine to learn the actions from saliency maps of different motion images. Despite its simplicity, the motion-difference method achieved very good performance in benchmark datasets, specifically the Weizmann dataset (98.81\%) and the KTH dataset (88.89\%). A comparative analysis with hand-crafted and learned features using similar classifiers indicates that motion-difference can be competitive and very efficient.

P521 *Color Image Processing Based on Nonnegative Matrix Factorization with Convolutional Neural Network [#N-14904]*

Thanh Xuan Luong, Bo-Kyeong Kim and Soo-Young Lee, Korea Advanced Institute of Science and Technology, Korea, Republic of

Although Nonnegative Matrix Factorization (NMF) has been widely known as an effective feature extraction method, which provides part-based representation and good reconstruction, there were relatively few researches using NMF for color image processing. Particularly, many studies are now using Convolutional Neural Network (CNN) in combined with Auto-Encoder (AE) or Restricted Boltzmann Machine (RBM) for learning features of color images. In this paper, we explore the ability of NMF to handle color images. Especially, a new method using NMF to learn features in CNN is proposed. In our experiments conducted on CIFAR-10, NMF shows the feasibility for reconstruction and classification of color images. Furthermore, unlike edge- or curve- shaped features learned by AE and RBM in CNN, our method provides dot- shaped features. These new types of features could be considered as basic building blocks in the lowest level of constructing images. Our results demonstrate that NMF is capable of being a supporting tool for CNN in learning features.

P522 *Bottom-Up Model of Visual Saliency: A Viewpoint Based on Efficient Coding Hypothesis [#N-14924]*

Hao Zhu and Biao Han, 3M Cogent Beijing, China; Universite 'deToulouse, Centrede Recherche Cerveauet Cognition, France

This paper proposes a novel bottom-up saliency model based on the mechanism of the early vision system. A relationship between the efficient coding theory and bottom-up saliency map in primate visual cortex is established. In this paper, we make a distinction of neural response between activated and inactivated by sparse coding, and define the saliency as uncertainity of internal representation. Beyond the definition of saliency, our model also accounts for the issue of why we need such a saliency map. Finally, we test this model on artificial images such as psychological patterns and two different scale datasets. Although it is only a simple model of bottom-up saliency, the experiment results show it outperforms other state-of-the- art methods.

P523 *Using Self-Organizing Incremental Neural Network (SOINN) for Radial Basis Function Networks [#N-14442]*

Jie Lu, Furao Shen and Jinxi Zhao, Nanjing University, China

This paper presents a batch learning algorithm and an online learning algorithm for radial basis function networks based on the self-organizing incremental neural network (SOINN), together referred to as SOINN-RBF. The batch SOINN-RBF is a combination of SOINN and least square algorithm. It achieves a comparable performance with SVM for regression. The online SOINN-RBF is based on the self- adaption procedure of SOINN and adopts the growing and pruning strategy of the minimal resource allocation network (MRAN). A redefined significance which is originally introduced by the generalized the growing and pruning algorithm for RBF (GGAP-RBF), are used in the growing and pruning criteria. Simulation results for both artificial and real-world data set show that, comparing with other

online algorithms, the online SOINN-RBF has comparable approximation accuracy, network compactness and better learning efficiency.

P524 *A New Multi-Task Learning Based Wi-Fi Location Approach Using $L_1/2$-Norm [#N-14486]*

Wentao Mao, Haicheng Wang and Shangwang Liu, Henan Normal University, China; Tsinghua University, China

While many existing multi-task learning based Wi-Fi location approaches pay more attention on the location performance, they generally neglect determining key access points(APs). In order to reduce maintenance cost in complex indoor environment, a new multi-task learning based Wi-Fi location approach is proposed to find the key APs with enough accuracy. First, we introduce extreme learning machine as basic method to establish a new multi-task learning machine. This machine is based on the assumption that the hypotheses learned from a latent feature space, rather than the original high-dimensional feature space, are similar, in which $L_{1/2}$-norm is utilized to construct $L_{2-1/2}$-norm to achieve joint feature selection in multi-task scenario. An alternating optimization method is employed to solve this problem, by iteratively optimizing the latent space and key features. Experiments on real-world indoor localization data are conducted, and the results demonstrate the effectiveness of the proposed approach.

P525 *A Combined Model for Scan Path in Pedestrian Searching [#N-14498]*

Lijuan Duan, Zeming Zhao, Wei Ma, Jili Gu, Yuanhua Qiao and Zhen Yang, Beijing University of Technology, China

Target searching, i.e. fast locating target objects in images or videos, has attracted much attention in computer vision. A comprehensive understanding of factors influencing human visual searching is essential to design target searching algorithms for computer vision systems. In this paper, we propose a combined model to generate scan paths for computer vision to follow to search targets in images. The model explores and integrates three factors influencing human vision searching, top-down target information, spatial context and bottom- up visual saliency, respectively. The effectiveness of the combined model is evaluated by comparing the generated scan paths with human vision fixation sequences to locate targets in the same images. The evaluation strategy is also used to learn the optimal weighting coefficients of the factors through linear search. In the meanwhile, the performances of every single one of the factors and their arbitrary combinations are examined. Through plenty of experiments, we prove that the top-down target information is the most important factor influencing the accuracy of target searching. The effects from the bottom-up visual saliency are limited. Any combinations of the three factors have better performances than each single component factor. The scan paths obtained by the proposed model are optimal, since they are most similar to the human vision fixation sequences.

P526 *Gain Parameters Based Complex-Valued BackPropagation Algorithm for Learning and Recognizing Hand Gestures [#N-14499]*

Yuanshan Liu, He Huang and Tingwen Huang, Soochow University, China; Texas A M University at Qatar, Qatar

In this paper, an improved complex-valued backpropagation algorithm with gain parameters is proposed. It is then employed to train a complex-valued feedforward neural network with one hidden layer. The well-trained complex-valued neural network is finally applied to deal with the recognition problem of 26 hand gestures. The results of experiment clearly show that much better performance can be achieved by our improved complex-valued backpropagation algorithm than some existing methods.

P527 *Tension Identification of Two-Motor System Based on Neural Network Left-Inverse [#N-14502]*

Guohai Liu, Zhennan Cai, Wenxiang Zhao, Hao Zhang, Yan Jiang and Yaojie Mi, Jiangsu University, China

Tension detection is a key to improve performance of two-motor system under sensorless operation. This paper presents a new identification method for two- motor system based on artificial neural network and the left-inverse theory. Considering that the system parameters are time-variant and the mathematic model of left-inverse identification is complex, BP neural network is used to build the left-inverse model in this method, which is easy to implement. A simulation model of a two-motor system is developed. The simulated results verify the proposed method. By using this control strategy, the tension can be identified quickly and accurately, in which satisfactory robustness is offered.

P528 *Sideslip Angle Soft-Sensor Based on Neural Network Left Inversion for Multi-Wheel Independently Driven Electric Vehicles [#N-14506]*

Penghu Miao, Guohai Liu, Duo Zhang, Yan Jiang, Hao Zhang and Huawei Zhou, Jiangsu University, China

Effective estimation of vehicle states such as the yaw rate and the sideslip angle is important for vehicle stability control. Unfortunately the devices are very expensive to measure the sideslip angle directly and are not suitable for ordinary vehicle. Therefore, it must be estimated. A novel sideslip angle soft-sensor using neural network left inversion (NNLI) is presented for the in-wheel motor driven electric vehicle (EV). The innovation of the presented algorithm is not only little concerned with reference model parameters identification, but also uses the characteristic of the in-wheel motor driven EV. Longitudinal acceleration, lateral acceleration, yaw rate, longitudinal velocity, steering angle, the torque of in-wheel motor which can be acquired by ordinary sensors are used as inputs. Co-simulations are carried out to demonstrate the effectiveness of the proposed soft-sensor with Simulink and CarSim.

P529 *Fast Support Vector Data Description Training Using Edge Detection on Large Datasets [#N-14541]*

Chenlong Hu, Bo Zhou and Jinglu Hu, Waseda University, Japan

Support Vector Data Description (SVDD) inherits properties of Support Vector Machines (SVM) and has become a prominent One Class Classifier (OCC). Same to standard SVM, its O(n3) time and O(n2) space complexities, where n is the number of training samples, have become major limitations in cases of large training datasets. As a simple and effective method, reducing the size of training dataset through reserving only samples mostly relevant to learned classifier, can be adopted to overcome the limitations. A trained SVDD enclosed decision boundary always locates on edge area of data distribution and is decided by a small subset of Support Vectors(SVs). Therefore, in this paper, we present a method based on edge detection such that edge samples mostly relevant to decision boundary can be preserved. And clustering techniques are also be applied to keep centroids representing the global distribution properties so as to avoid over-outside of decision boundary. To restrict the influences of noises, each training pattern is assigned with a weight. Experiments on real and artificial data sets prove that the classifier trained on reconstruction training set consisting of edge points and centroids can preserve performance with much faster training speed.

P530 *A Half-Split Grid Clustering Algorithm by Simulating Cell Division [#N-14543]*

Wenxiang Dou and Jinglu Hu, Waseda University, Japan

Clustering, one of the important data mining techniques, has two main processing methods on data-based similarity clustering and space-based density grid clustering. The latter has more advantage than the former on larger and multiple shape and density dataset. However, due to a global partition of existing grid- based methods, they will perform worse when there is a big difference on the density of clusters. In this paper, we propose a

novel algorithm that can produces appropriate grid space in different density regions by simulating cell division process. The time complexity of the algorithm is O(n) in which n is number of points in dataset. The proposed algorithm will be applied on popular chameleon datasets and our synthetic datasets with big density difference. The results show our algorithm is effective on any multi-density situation and has scalability on space optimization problems

P531 *Stochastic Gradient Based Iterative Identification Algorithm for a Class of Dual-Rate Wiener Systems [#N-14553]*

Jing Leng, Junpeng Li, Changchun Hua and Xinping Guan, Yanshan University, China

Parameter estimation problem is considered for a class of dual-rate Wiener systems whose input-output data are measured by two different sampling rate. Firstly, a polynomial transformation technique is used to derive a mathematical model for such dual-rate Wiener systems. Then, directly based on the dual-rate sampled data, a dual-rate Wiener systems stochastic gradient algorithm (DRW-SG) is presented. In order to improve the algorithm convergence rate, a dual-rate Wiener systems stochastic gradient algorithm with a forgetting factor algorithm (DRW-FF-SG) is presented. For making full use of the forgetting factor, a dual-rate Wiener systems stochastic gradient algorithm with an increasing forgetting factor algorithm (DRW-IFF-SG) is presented which performs excellently. Finally, an example is provided to test and illustrate the proposed algorithms.

P532 *Wiener Model Identification of Blast Furnace Ironmaking Process Based on Laguerre Filter and Linear Programming Support Vector Regression [#N-14554]*

Xia Xu, Changchun Hua, Yinggan Tang and Xinping Guan, Yanshan University, China

As a highly complex multi-input and multi-output system, blast furnace plays an important role in industrial development. Although much research has been done in the past few decades, there still exist many problems, such as the modeling and control problems. In view of these reasons, this paper is concerned with developing a Wiener model to predict the silicon content of blast furnace. Unlike traditional Wiener model, this paper avoids the optimization of high number of model parameters. The Wiener model here is composed of a basis filter filter expansion named Laguerre filter and a linear programming support vector regression (LP-SVR). They are used to represent the linear dynamic component and the nonlinear static element respectively. Take the advantages that Laguerre filter can approximate linear systems with a lower model and order and LP-SVR can achieve a sparse solution, the proposed Wiener model not only improves the prediction accuracy but also reduces the computation complexity. Simulation results show that this Wiener model is suitable for the prediction of blast furnace silicon content.

P533 *Learning Features from High Speed Train Vibration Signals with Deep Belief Networks [#N-14558]*

Jipeng Xie, Yan Yang, Tianli Li and Weidong Jin, Southwest Jiaotong University, China

Feature extraction is one of key steps in fault diagnosis for High Speed Train (HST). In this work, we present a method that can automatically extract high-level features from HST vibration signals and recognize the faults. The method is composed of a Deep Belief Network (DBN) on Fast Fourier Transform (FFT) of vibration signals. DBNs can be trained greedily, layer by layer, using a model referred to as a Restricted Boltzmann Machine (RBM). The real data sets and simulation data sets of HST vibration signals are selected in experiments. First, the vibration signals are preprocessed by FFT. Then, the FFT coefficient-vectors are used to set the states of the visible units of DBNs. Finally, n label units are connected to the "top" layer of the DBNs to identify different faults. The experimental results show that the method may learn useful high-level features from vibration signals and diagnose the different faults of HST.

P534 *A Neural Network and SOM Based Approach to Analyse Periodic Signals: Application to Oyster Heart-Rate Data [#N-14560]*

Andrew Hellicar, Ashfaqur Rahman, Daniel Smith, Greg Smith and John McCulloch, Commonwealth Scientific and Industrial Research Organisation, Australia

New sensor streams are being generated at a rapidly increasing rate. The sources of these streams are a diverse set of networked sensors, diverse both in sensing hardware and sensing modality. Machine learning algorithms are ideally placed to develop generalized methods for stream analysis. One exemplar problem is the detection and analysis of periodic structure within these streams. Our contribution is the proposal of a new machine learning framework that (i) classifies a signal as periodic or aperiodic, (ii) further analyses the signal to find periodic structure using a neural network, and (iii) groups the motifs in the periodic signals using a modified Self Organising Map algorithm. We also demonstrate the framework using data generated by an Oyster heart rate sensor. We find that the generalized approach our classifier improves the detection of signal periods by reducing the number of functions classified as periodic from 11% to 9%; however, most benefit occurs for period calculation with the number of erroneously calculated periods reducing from 14% to 4%.

P535 *Bayesian Network Scores Based Text Localization in Scene Images [#N-14561]*

Khalid Iqbal, Xu-Cheng Yin, Hong-Wei Hao, Sohail Asghar and Hazrat Ali, University of Science and Technology Beijing, China; Institute of Automation, Chinese Academy of Sciences, China; Arid Agriculture University Rawalpindi, Pakistan; City University London, United Kingdom

Text localization in scene images is an essential and interesting task to analyze the image contents. In this work, a Bayesian network scores using K2 algorithm in conjunction with the geometric features based effective text localization method with the help of maximally stable extremal regions (MSERs). First, all MSER-based extracted candidate characters are directly compared with an existing text localization method to find text regions. Second, adjacent extracted MSER-based candidate characters are not encompassed into text regions due to strict edges constraint. Therefore, extracted candidate character regions are incorporated into text regions using selection rules. Third, K2 algorithm-based Bayesian networks scores are learned for the complimentary candidate character regions. Bayesian logistic regression classifier is built on the Bayesian network scores by computing the posterior probability of complimentary candidate character region corresponding to non-character candidates. The higher posterior probability of complimentary Candidate character regions are further grouped into words or sentences. Bayesian networks scores based text localization system, named asBayesText,isevaluated on ICDAR 2013 Robust Reading Competition (Challenge 2 Task 2.1: Text Localization) database. Experimental results have established significant competitive performance with the state-of-the-art text detection systems.

P536 *Implementation of Memristive Neural Networks with Spike-Rate-Dependent Plasticity Synapses [#N-14574]*

Yide Zhang, Zhigang Zeng and Shiping Wen, Huazhong University of Science and Technology, China

The property of changing resistance according to applied currents of memristors makes them candidates for emulating synapses in artificial neural networks. In this paper, we introduce a memristive synapse design into neural network circuits. Combined with modified integrate-and-fire complementary metal-oxide- semiconducter (CMOS) neurons, the memristive neural network shows similarities to its biological counterpart, in respect of biologically realistic, current- controlled spikes and adaptive synaptic

plasticity. Then, the spike-rate-dependent plasticity (SRDP) of the synapse, an extended protocol of the Hebbian learning rule, is originally implemented by the circuit. And some advanced neural activities including learning, associative memory and forgetting are realized based on the SRDP rule. These activities are comprehensively validated on a neural network circuit inspired by famous Pavlov's dog-experiment with simulations and quantitative analyses.

P537 *Evaluation of Active Position Detection in Vehicular Ad Hoc Networks [#N-14959]*

Kiran Penna, Venkatesh Yalavarthi, Huirong Fu and Ye Zhu, Oakland University, United States; Cleveland State University, United States

Vehicular Ad Hoc Network (VANET) is a promising technology in which vehicle-to-vehicle and vehicle-to-roadside infrastructure wireless communications can be achieved. This is important to obtain road safety for vehicles and drivers and collision avoidance. A falsified position by malicious users is one of the important issues in VANETs. Vehicle position identification is one of the important aspects in establishing authentication and security between inter vehicular communication exchange. Deepa et al presented two approaches for verifying sender's position in a multi-hop network. Their first proposed algorithm relies on signal propagation time for verifying the position. Their second proposed algorithm verifies the position information with the help of base stations located in the coverage area of the vehicular network. The main contribution of our work is validating their approach by running an ns2 simulation with dynamic number of nodes in various mobility scenarios such as urban, rural, Manhattan. We have also generated different scenarios with variable velocity ranges and simulated the VANET. We have also considered the effect of delay, jitter in our simulation and observed that the proposed approach is robust and a feasible solution to the problem of Active Position detection.

P538 *Smart Bandwidth Management Using a Recurrent Neuro-Evolutionary Technique [#N-14556]*

Rabia Arshad, Gul Muhammad Khan and Sahibzada Ali Mahmud, University of Engineering and Technology Peshawar, Pakistan

The requirement for correct bandwidth allocation and management in a multitude of different communication mediums has generated some exceedingly tedious challenges that need to be addressed both intelligently and with innovative solutions. Current advances in high speed broadband technologies have manifold increased the amount of bandwidth required during successful multimedia streaming. The progressive growth of Neuro-Evolutionary techniques have presented themselves as worthy options to address many of the challenges faced during multimedia streaming. In this paper a Neuro-Evolutionary technique called the Recurrent Cartesian Genetic Programming Evolved Artificial Neural Network(RCGPANN) is presented for prediction of future frame sizes. The proposed technique takes into account the traffic size trend of the historically transmitted data for future frame size prediction. The predicted frame size forms the basis for estimation of the amount of bandwidth necessary for transmission of future frame. Different linear regression and probabilistic approaches are employed to estimate the allocated bandwidth, while utilizing the predicted frame size. Our proposed intelligent traffic size prediction along with bandwidth estimation and management results in a 98% increased efficiency.

P539 *Analog Memristive Time Dependent Learning Using Discrete Nanoscale RRAM Devices [#N-14843]*

Aniket Singha, Bhaskaran Muralidharan and Bipin Rajendran, Indian Institute of Technology Bombay, India

We propose a scheme that mimics the analog time dependent learning characteristics of biological synapses using a small set of discrete nanoscale RRAM devices whose switching voltages vary stochastically. Using numerical models and simulations, we demonstrate that a voltage limited analog memristor operating in the tunneling regime and a parallel combination of less than 10 RRAM devices having discrete resistance states can both be employed as artificial synapses with similar statistical performance. We also show that by appropriately choosing the programming voltages and hence the switching probability of the RRAM devices, it is possible to tune the relative conductance of the synaptic element anywhere in the range of 2-100. This paper thus shows the possibility of using discrete RRAM devices to realize an analog functionality in artificial learning systems.

P540 *Data Intensive Parallel Feature Selection Method Study [#N-14080]*

Zhanquan Sun and Zhao Li, Shandong Computer Science Center, China

Feature selection is an important research topic in machine learning and pattern recognition. It is effective in reducing dimensionality, removing irrelevant data, increasing learning accuracy, and improving result comprehensibility. With the development of computer science, data deluge occurs in many application fields. Classical feature selection method is out of work in processing large-scale dataset because of expensive computational cost. This paper mainly concentrates on the study of data intensive parallel feature selection method. The parallel feature selection method is based on MapReduce program model. In each map node, a novel method is used to calculate the mutual information and combinatory contribution degree is used to determine the number of selected features. Selected features of map node are combined into a global selected feature in reduce node. The parallel feature selection method is scalable. The efficiency of the method is illustrated through an example analysis.

P541 *Kernel Ridge Regression Classification [#N-14063]*

Jinrong He, Lixin Ding, Lei Jiang and Ling Ma, Wuhan University, China; Hunan University of Science and Technology, China; Second Artillery Equipment Academy, China

We present a nearest nonlinear subspace classifier that extended ridge regression classification method to kernel version which is called Kernel Ridge Regression Classification (KRRC). Kernel method is usually considered effective in discovering the nonlinear structure of the data manifold. The basic idea of KRRC is to implicitly map the observed data into potentially much higher dimensional feature space by using kernel trick and perform ridge regression classification in feature space. In this new feature space, samples from a single-object class may lie on a linear subspace, such that a new test sample can be represented as a linear combination of class-specific galleries, then the minimum distance between the new test sample and class specific subspace is used for classification. Our experimental studies on synthetic data sets and some UCI benchmark datasets confirm the effectiveness of the proposed method.

P542 *Causality Traces for Retrospective Learning in Neural Networks - Introduction of Parallel and Subjective Time Scales [#N-14621]*

Katsunari Shibata, Oita Univerity, Japan

We live in the flow of time, and the sensor signals we get not only have a huge amount in space, but also keep coming without a break in time. As a general method for effective retrospective learning in neural networks (NNs) in such a world based on the concept of ``subjective time'', ``causality trace'' is introduced in this paper. At each connection in each neuron, a trace is assigned. It takes in the corresponding input signal according to the temporal change in the neuron's output, and is held when the output does not change. This enables to memorize only past important events, to hold them in its local memory, and to learn the past processes effectively from the present reinforcement or training signals without tracing back to the past. The past events that the traces represent are different in each neuron, and so autonomous division of roles in the time axis among neurons is promoted through learning. From the viewpoint of time passage, there are parallel, non-uniform and subjective time scales for learning in the NN. Causality traces can be applied to value learning with a NN, and also applied to supervised learning of recurrent neural networks even though the way of application is a bit different. A new simulation result in a value-learning task shows the outstanding learning ability of causality traces and autonomous division of roles in the time axis among neurons through learning. Finally, several useful properties and concerns are discussed.

P543 *Hardware Implementation of KLMS Algorithm Using FPGA [#N-14503]*

Xiaowei Ren, Pengju Ren, Badong Chen, Tai Min and Nanning Zheng, Xi'an Jiaotong University, China; Interuniversity Microelectronics Centre, Belgium

Fast and accurate machine learning algorithms are needed in many physical applications. However, the learning efficiency is badly subjected to the intensive computation. Knowing that hardware implementation could speed up computation effectively, we use a FPGA hardware platform to implement an on-line kernel learning algorithm, namely the kernel least mean square (KLMS) which adopts the simple survival kernel as the Mercer kernel. By using an on-line quantization method and pipeline technology, the requirement of hardware resources and computation burden can be reduced significantly and the data processing speed can be accelerated apparently without losing accuracy. Finally, a 128-way parallel FPGA platform which works at 200MHz is implemented. It could achieve an average speedup of 6553 versus Matlab running on a 3GHz Intel(R) Core(TM) i5-2320 CPU.

P544 *Parallelized Neural Networks as a Service [#N-14579]*

Altaf Ahmad Huqqani, Erich Schikuta and Erwin Mann, University of Vienna, Austria

We present a novel neural network simulation framework, which provides the parallelized execution of artificial neural network by exploiting modern hardware and software environments adhering to the service oriented paradigm within the N2Sky system. The goal of the N2Sky system is to share and exchange neural network resources, neural network specific knowledge, neural network objects and paradigms and, in turn, to deliver a transparent environment to novice and experienced users to do neural network research. The parallelization techniques are deployed transparently for the user reducing significantly the time consuming training of neural networks by selecting appropriate service implementation according to complexity of the problem. N2Sky follows the sky computing paradigm fostering ample resources by using federated clouds.

Wednesday, July 9, 4:00PM-6:00PM

Special Session: WeN2-1 Plenary and Discussion Session of International Workshops

Wednesday, July 9, 4:00PM-6:00PM, Room: 308, Chair: Stefano Squartini and Nistor Grozavu

4:00PM *Plenary Lecture of the International Workshops*

Paul Werbos, National Science Foundation, United States

The two international workshops at IJCNN 2014 (Computational Energy Management in Smart Grids and Advances in Learning from/with Multiple Learners) will join together at this session. Paul Werbos will present a plenary lecture, followed by discussions.

4:50PM *Follow-up Discussion of the Two International Workshops*

Stefamo Squartini and Nistor Grozavu, Universita Politecnica delle Marche, Italy; LIPN UMR CNRS 7030, Paris 13 University, France

The two international workshops (Computational Energy Management in Smart Grids and Advances in Learning from/with Multiple Learners) will use this time slot for their follow-up discussion. The discussion will be led by Stefano Squartini and Nistor Grozavu.

Special Session: WeN2-2 Learning and Optimization in Multi-criteria Dynamic and Uncertain Environments

Wednesday, July 9, 4:00PM-6:00PM, Room: 305A, Chair: Madalina Drugan and Peter Vrancx

4:00PM *The Scalarized Multi-Objective Multi-Armed Bandit Problem: An Empirical Study of Its Exploration vs. Exploitation Tradeoff [#N-14054]*

Saba Yahyaa, Madalina Drugan and Bernard Manderick, Vrije Universiteit Brussel, Belgium

The multi-armed bandit (MAB) problem is the simplest sequential decision process with stochastic rewards where an agent chooses repeatedly from different arms to identify as soon as possible the optimal arm, i.e. the one of the highest mean reward. Both the knowledge gradient (KG) policy and the upper confidence bound (UCB) policy work well in practice for the MAB-problem because of a good balance between exploitation and exploration while choosing arms. In case of the multi-objective MAB (or MOMAB)-problem, arms generate a vector of rewards, one per arm, instead of a single scalar reward. In this paper, we extend the KG-policy to address multi-objective problems using scalarization functions that transform reward vectors into single scalar reward. We consider different scalarization functions and we call the corresponding class of algorithms \emph{scalarized KG}. We compare the resulting algorithms with the corresponding variants of the multi- objective UCB1-policy (MO-UCB1) on a number of MOMAB-problems where the reward vectors are drawn from a multivariate normal distribution. We compare experimentally the exploration versus exploitation trade-off and we conclude that scalarized- KG outperforms MO-UCB1 on these test problems.

4:20PM *Accelerating Learning in Multi-Objective Systems through Transfer Learning [#N-14123]*

Adam Taylor, Ivana Dusparic, Edgar Galvan-Lopez, Siobhan Clarke and Vinny Cahill, Trinity College Dublin, Ireland

Large-scale, multi-agent systems are too complex for optimal control strategies to be known at design time and as a result good strategies must be learned at runtime. Learning in such systems, particularly those with multiple objectives, takes a considerable amount of time because of the size of the environment and dependencies between goals. Transfer Learning (TL) has been shown to reduce learning time in single-agent, single-objective applications. It is the process of sharing knowledge between two learning tasks called the source and target. The source is required to have been completed prior to the target task. This work proposes extending TL to multi-agent, multi-objective applications. To achieve this, an on-line version of TL called Parallel Transfer Learning (PTL) is presented. The issues involved in extending this algorithm to a multi- objective form are discussed. The effectiveness of this approach is evaluated in a smart grid scenario. When using PTL in this scenario learning is significantly accelerated. PTL achieves comparable performance to the base line in one third of the time.

4:40PM *A Novel Adaptive Weight Selection Algorithm for Multi-Objective Multi-Agent Reinforcement Learning [#N-14422]*

Kristof Van Moffaert, Tim Brys, Arjun Chandra, Lukas Esterle, Peter Lewis and Ann Nowe, Vrije Universiteit Brussel, Belgium; University of Oslo, Norway; Alpen-Adria Universitat Klagenfurt, Austria; Aston University, United Kingdom

To solve multi-objective problems, multiple reward signals are often scalarized into a single value and further processed using established single-objective problem solving techniques. While the field of multi- objective optimization has made many advances in applying scalarization techniques to obtain good solution trade-offs, the utility of applying these techniques in the multi-objective multi-agent learning domain has not yet been thoroughly investigated. Agents learn the value of their decisions by linearly scalarizing their reward signals at the local level, while acceptable system wide behaviour results. However, the non-linear relationship between weighting parameters of the scalarization function and the learned policy makes the discovery of system wide trade-offs time consuming. Our first contribution is a thorough analysis of well known scalarization schemes within the multi-objective multi-agent reinforcement learning setup. The analysed approaches intelligently explore the weight-space in order to find a wider range of system trade-offs. In our second contribution, we propose a novel adaptive weight algorithm which interacts with the underlying local multi-objective solvers and allows for a better coverage of the Pareto front. Our third contribution is the experimental validation of our approach by learning bi-objective policies in self-organising smart camera networks. We note that our algorithm (i) explores the objective space faster on many problem instances, (ii) obtained solutions that exhibit a larger hypervolume, while (iii) acquiring a greater spread in the objective space.

5:00PM *Multi-Objectivization of Reinforcement Learning Problems by Reward Shaping [#N-14563]*

Tim Brys, Anna Harutyunyan, Peter Vrancx, Matthew E. Taylor, Daniel Kudenko and Ann Nowe, Vrije Universiteit Brussel, Belgium; Washington State University, United States; York University, United Kingdom

Multi-objectivization is the process of transforming a single objective problem into a multi-objective problem. Research in evolutionary optimization has demonstrated that the addition of objectives that are correlated with the original objective can make the resulting problem easier to solve compared to the original single-objective problem. In this paper we investigate the multi-objectivization of reinforcement learning problems. We propose a novel method for the multi-objectivization of Markov Decision problems through the use of multiple reward shaping functions. Reward shaping is a technique to speed up reinforcement learning by including additional heuristic knowledge in the reward signal. The resulting composite reward signal is expected to be more informative during learning, leading the learner to identify good actions more quickly. Good reward shaping functions are by definition correlated with the target value function for the base reward signal, and we show in this paper that adding several correlated signals can help to solve the basic single objective problem faster and better. We prove that the total ordering of solutions, and by consequence the optimality of solutions, is preserved in this process, and empirically demonstrate the usefulness of this approach on two reinforcement learning tasks: a pathfinding problem and the Mario domain.

5:20PM *Policy Gradient Approaches for Multi-Objective Sequential Decision Making [#N-14569]*

Simone Parisi, Matteo Pirotta, Nicola Smacchia, Luca Bascetta and Marcello Restelli, Politecnico di Milano, Italy

This paper investigates the use of policy gradient techniques to approximate the Pareto frontier in Multi-Objective Markov Decision Processes (MOMDPs). Despite the popularity of policy gradient algorithms and the fact that gradient ascent algorithms have been already proposed to numerically solve multi-objective optimization problems, especially in combination with multi-objective evolutionary algorithms, so far little attention has been paid to the use of gradient information to face multi-objective sequential decision problems. Two different Multi-Objective Reinforcement-Learning (MORL) approaches, called radial and Pareto following, that, starting from an initial policy, perform gradient-based policy-search procedures aimed at finding a set of non-dominated policies are here presented. Both algorithms are empirically evaluated and compared to state-of-the-art MORL algorithms on three MORL benchmark problems.

5:40PM *Multi-Objective X-Armed Bandits [#N-14599]*

Kristof Van Moffaert, Kevin Van Vaerenbergh, Peter Vrancx and Ann Nowe, Vrije Universiteit Brussel, Belgium

Many of the current optimization algorithms focus on optimizing a single, scalar feedback signal. However, real-life optimization problems often require a simultaneous optimization of more than one objective. In this paper, we propose a multi-objective extension to the standard X-armed bandit problem. As the feedback signal is now vector-valued, the goal of the agent is to sample actions in the Pareto dominating area of the objective space. Therefore, we propose the multi-objective Hierarchical Optimistic Optimization strategy that discretizes the continuous action space in relation to the Pareto optimal solutions obtained in the multi-objective objective space. We experimentally validate the approach on two well-known multi- objective test functions and a simulation of a real life application, the filling phase of a wet clutch. We demonstrate that the strategy allows to identify the Pareto front after just a few epochs and to sample accordingly. After learning, several multi-objective quality indicators indicate that the set of sampled solutions by the algorithm very closely approaches the Pareto front.

Special Session: WeN2-3 Machine Learning for Computer Vision II

Wednesday, July 9, 4:00PM-6:00PM, Room: 305B, Chair: Brijesh Verma and Mohammed Bennamoun

4:00PM *An Interpretable Graph-Based Image Classifier [#N-14368]*

Filippo Maria Bianchi, Simone Scardapane, Lorenzo Livi, Aurelio Uncini and Antonello Rizzi, Sapienza University of Rome, Italy

The generalization capability is usually recognized as the most desired peculiarity of data-driven learning systems, such as classifiers. However, in many practical applications, obtaining human-understandable information from the classification model that is also relevant to the problem at hand can be equally important. We present a classification system able to fulfill these two requirements simultaneously for a generic image classification task. As a first preprocessing step, an input image to the classifier is represented by a labeled graph, relying on a segmentation algorithm. The graph is conceived to represent visual and topological information of the relevant segments of the image. Then, the graph is classified by a suited inductive inference engine. In the learning procedure all the training set images are represented by graphs, feeding a state-of-the-art classification system working on structured domains. The synthesis procedure consists in extracting characterizing subgraphs from the training set, which are used to embed the graphs into a vector space, enabling thus the applicability of well-known classifiers for feature-based patterns. Such characterizing subgraphs, which are derived in an unsupervised fashion, are interpretable by suitable field experts, allowing a semantic analysis of the discovered classification rules for the given problem at hand. The system is optimized with a genetic algorithm, which tunes the system parameters according to a cross-validation scheme.

We show the validity of the approach by performing experiments considering some image classification problems derived from an on-line repository.

4:20PM *Off-Line Handwritten Thai Name Recognition for Student Identification in an Automated Assessment System [#N-14455]*

Hemmaphan Suwanwiwat, Michael Blumenstein, Vu Nguyen and Umapada Pal, Griffith University, Australia; Indian Statistical Institute, India

In the field of pattern recognition, off-line handwriting recognition is one of the most intensive areas of study. This paper proposes an automatic off-line Thai language student name identification system which was built as a part of a completed off-line automated assessment system. There is limited work undertaken in developing off-line automatic assessment systems using handwriting recognition. To the authors' knowledge, none of the work on the proposed system has been performed on the Thai language. In addition the proposed system recognises each Thai name by using an approach for whole word recognition, which is different from the work found in the literature as most perform character- based recognition. In this proposed system, the Gaussian Grid Feature (GGF) and the Modified Direction Feature (MDF) extraction techniques are investigated on upper and lower contours, holes from full word contour images of each name sample, and artificial neural networks and support vector machine are used as classifiers. The encouraging recognition rates for both feature extraction techniques were achieved when applied on hole, upper and lower contour images (99.27% was achieved using MDF on artificial neural networks and 99.27% using GGF with a support vector machine classifier).

4:40PM *Feature Extraction in X-Ray Images for Hazelnuts Classification [#N-14461]*

Khosa Ikramullah and Eros Pasero, Politecnico di Torino, Italy

In the food industry, the importance of automatic detection and selection of raw food ingredients is increasing. In this paper, a method for real time automatic detection, segmentation and classification of hazelnuts using x-ray images is presented. Automatic extraction of independent nut images is made using image processing techniques. To extract meaningful features, moment invariants and texture properties are calculated on global level as well as from co-occurrence matrices. Principal component analysis is applied on features to achieve orthogonality in addition to dimensionality reduction. An anomaly detection algorithm is used for classification. Multivariate Gaussian distributions are calculated for model estimation using training data. Results are calculated on test data by using the threshold value obtained from best validation outcome. The classifier showed 98.6% correct classification rate for negative examples with 0% false negative rate

5:00PM *A New Fuzzy Shape Context Approach Based on Multi-Clue and State Reservoir Computing [#N-14681]*

Zhidong Deng, Kelaiti Xiao and Jing Huang, Tsinghua University, China

This paper first builds a rule-based fuzzy representation of shape context and then present a multi-clue based fuzzy shape context approach (MFSC) using combination of geometric information and graph transduction. The MFSC takes complexity of object shape into account. In this approach, the distance between arbitrary two sampled points on any shape is redefined and graph transduction is used to correct and compensate training error. Furthermore, we propose a new fuzzy shape context approach based on both multi-clue and state reservoir computing. The experimental results show that the accuracy of detection achieved by our new approach on Kimia-216 and Kimia-99 datasets reaches up to 99.35% and 98.56%, respectively, which outperforms that of all the state-of-the- art shape context approaches.

5:20PM *Structure-from-Motion Reconstruction Based on Weighted Hamming Descriptors [#N-14853]*

Guoyu Lu, Vincent Ly and Chandra Kambhamettu, University of Delaware, United States

We propose a pipelined methods to reduce memory consumption of large-scale Structure-from-Motion reconstruction with the use of unsorted images extracted from photo collection websites. Recent research is able to reconstruct cities based on extracted images from photo collection websites. SIFT feature is used to find the correspondences between two images. For the large-scale reconstruction with unsorted images, the system needs to store all the descriptors and feature points information in memory to search for correspondences. As each SIFT descriptor is a 128 dimensional real-value vector, storing all the descriptors would consume a significant amount of memory. Based on this limitation, we project the high dimensional features into a low-dimensional space using a learned projection matrix. After projection, the distance of the descriptors belonging to the same point in 3D space is decreased; the distance of the descriptors belonging to the different points is increased. Furthermore, we learn a mapping function, which maps the real-value descriptor into binary code. As Hamming descriptors contain only two value options per bit and the length of the descriptor is limited, there are usually multiple descriptors having the same Hamming distance to the query descriptor. In dealing with this problem, we give different weights to each dimension and rank each bit of the Hamming descriptor based on each dimension's discriminant power; this contributes to reduce the ambiguity in matching the descriptors. The experiments show that our method achieves dense reconstruction results with less than 10 percent of the original memory consumption.

5:40PM *Local Binary Pattern Based Facial Expression Recognition Using Self-Organizing Map [#N-14598]*

Anima Majumder, Laxmidhar Behera and Venkatesh K. Subramanian, Indian Institute of Technology Kanpur, India

This paper presents an appearance feature based facial expression recognition system using Kohonen Self-Organizing Map (KSOM). Appearance features are extracted using uniform Local binary patterns (LBPs) from equally sub-divided blocks applied over face image. The dimensionality of the LBP feature vector is further reduced using principal component analysis (PCA) to remove the redundant data that leads to unnecessary computation cost. Using our proposed KSOM based classification approach, we train only 59 dimensional LBP features extracted from whole facial region. The classifier is designed to categorize six basic facial expressions (happiness, sadness, disgust, anger, surprise and fear). To validate the performance of the reduced 59 dimensional LBP feature vector, we also train the original data of dimension 944 using the KSOM. The results demonstrates, that with marginal degradation in overall recognition performance, the reduced 59 dimensional data obtains very good classification results. The paper also presents three more comparative studies based on widely used classifiers like; Support vector machine (SVM), Radial basis functions network (RBFN) and Multi-layer perceptron (MLP3). Our KSOM based approach outperforms all other classification methods with average recognition accuracy 69.18%. Whereas, the average recognition rated obtained by SVM, RBFN and MLP3 are 65.78%, 68.09% and 62.73% respectively.

WeN2-4 Spiking Neural Networks I

Wednesday, July 9, 4:00PM-6:00PM, Room: 305C, Chair: Nikola Kasabov and Nathan Scott

4:00PM *Does Plasticity Promote Criticality ? [#N-14311]*

Filipe Peliz Pinto Teixeira and Murray Shanahan, Imperial College London, United Kingdom

Neuronal avalanches are a cortical phenomenon characterized by bursts of activity bracketed by periods of quiescence. The size and length of avalanche events in vivo and in vitro appear to conform to power law-like distributions, suggesting the system is within or near a critical state. According to the Criticality Hypothesis, networks in such a state optimize information processing, information storage, computational power, and stability. This suggests the possibility that neural systems in nature self-organize via neuronal avalanches and a critical branching process into an optimal state. To better understand how network structure and its evolution affect optimality, this work investigates the interplay of network connectivity, synaptic plasticity, and criticality. Using the Watts-Strogatz and Klemm-Eguiluz construction algorithms, we synthesize a variety of network structures. Each structure undergoes the same learning process via Spike Timing Dependent Plasticity (STDP), which robustly drives the network towards either a sub-critical, critical or super-critical state, depending on the initial balance between excitatory and inhibitory strength. Our findings show that, while the initial distribution of synaptic weights plays a significant role in attaining criticality, the network's topology and associated network properties such as small-worldness and modularity at the local level have little or no impact.

4:20PM *Evolutionary Features and Parameter Optimization of Spiking Neural Networks for Unsupervised Learning [#N-14315]*

Marco Silva, Adriano Koshiyama, Marley Vellasco and Edson Cataldo, Pontifical Catholic University of Rio de Janeiro, Brazil; Federal Fluminense University, Brazil

This paper introduces two new hybrid models for clustering problems in which the input features and parameters of a spiking neural network (SNN) are optimized using evolutionary algorithms. We used two novel evolutionary approaches, the quantum-inspired evolutionary algorithm (QIEA) and the optimization by genetic programming (OGP) methods, to develop the quantum binary-real evolving SNN (QbrSNN) and the SNN optimized by genetic programming (SNN-OGP) neuro-evolutionary models, respectively. The proposed models are applied to 8 benchmark datasets, and a significantly higher clustering accuracy compared to a standard SNN without feature and parameter optimization is achieved with fewer iterations. When comparing QbrSNN and SNN-OGP, the former performed slightly better but at the expense of increased computational effort.

4:40PM *Stochastic Spiking Neural Networks at the Edge of Chaos [#N-14363]*

J.L. Rossello, V. Canals, A. Oliver and A. Morro, Univeristy of Balearic Islands, Spain

In this work we show a study about which processes are related to chaotic and synchronized neural states based on the study of in-silico implementation of Stochastic Spiking Neural Networks (SSNN). Chaotic neural ensembles are excellent transmission and convolution systems. At the same time, synchronized cells (that can be understood as ordered states of the brain) are associated to more complex non-linear computations. We experimentally show that complex and quick pattern recognition processes arise when both synchronized and chaotic states are mixed. These measurements are in accordance with in-vivo observations related to the role of neural synchrony in pattern recognition and to the speed of the real biological process. The measurements obtained from the hardware implementation of different types of neural systems suggest that the brain processing can be governed by the superposition of these two complementary states with complementary functionalities (non-linear processing for synchronized states and information convolution and parallelization for chaotic).

5:00PM *Phase Offset Between Slow Oscillatory Cortical Inputs Influences Competition in a Model of the Basal Ganglia [#N-14501]*

Zafeirios Fountas and Murray Shanahan, Imperial College London, United Kingdom

Low-frequency oscillations have been the target of extensive research both in cortical structures and in the basal ganglia, due to numerous reports of associations with brain disorders and the normal functioning of the brain. Whereas a number of computational models of the basal ganglia investigate these phenomena, these models tend to focus on intrinsic oscillatory mechanisms, neglecting evidence that points to the cortex as the origin of this oscillatory behaviour. In this work we constructed a neural model of the basal ganglia circuitry and used it to investigate the relationship between frequency of oscillatory cortical input, dopamine and the effectiveness of the basal ganglia as an action selection device. Our simulations show the impact of the phase offset between different cortical inputs. This was found to be highly dependent on the frequency band and to have a strong influence on basal ganglia effectiveness. In addition, the level of dopamine in the system was found to modulate this effect, also depending on the input's frequency band.

5:20PM *A Sequential Learning Algorithm for a Minimal Spiking Neural Network (MSNN) Classifier [#N-14636]*

Shirin Dora, Sundaram Suresh and Narasimhan Sundararajan, Nanyang Technological University, Singapore

In this paper, we develop a new sequential learning algorithm for a spiking neural network classifier. The algorithm handles the input features that are not in the form of a spike train but in a real-valued (analog) form. The sequential learning algorithm evolves the number of spiking neuron automatically based on the information present in the current sample and results in compact architecture. Hence, it is referred to as a Minimal Spiking Neural Network (MSNN). The learning algorithm can either add a new neuron to the network or update the parameters of the existing neurons based on the information contained in the arriving samples. The update rule uses excitatory/inhibitatory rule to capture the knowledge contained in the current sample. Performance evaluation of the proposed MSNN is presented using two benchmark problems from the UCI machine learning repository, namely, the Iris flower classification and Wisconsin breast cancer problem and the results are compared with other existing spiking neural algorithms like SpikeProp, MuSpiNN and Multi-spike learning algorithms. The results clearly indicate the better performance of MSNN with a compact architecture.

5:40PM *Large Scale Parameter Estimation of Nonlinear Dynamic Systems: Application on Spike-In, Spike-Out Neural Models [#N-14851]*

Alireza Dibazar, University of Southern California, United States

This paper presents a general method of parameter estimation for large-scale non- linear dynamic models a with particular focus on parameter estimation for spike- in, spike-out neural models. The aim is to provide a convex optimization algorithm for tuning parameters of such a model which enables solving large-scale estimation problem in a linear time. Parameter estimation for a single layer neural network containing hundreds of synapses is addressed and efficiency/performance of the proposed methodology is demonstrated by solving a few examples. It will be also demonstrated that parameters of the model for mapping CA3 output of hippocampus cell into CA1 output, under patch clamp experiment, can be successfully estimated by utilizing the methodology of this paper.

WeN2-5 Unsupervised Learning and Clustering II

Wednesday, July 9, 4:00PM-6:00PM, Room: 305D, Chair: Akira Hirose

4:00PM *An Unsupervised Material Learning Method for Imaging Spectroscopy [#N-14128]*

Johannes Jordan, Elli Angelopoulou and Antonio Robles-Kelly, University of Erlangen-Nuremberg, Germany; National ICT Australia, Australia

In this paper we propose a method for learning the materials in a scene in an unsupervised manner making use of imaging spectroscopy data. Here, we view the input image spectra as a data point on a manifold which corresponds to a node in a graph whose vertices correspond to a set of parameters that should be inferred using the Expectation Maximisation (EM) algorithm. In this manner, we can pose the problem as a statistical unsupervised learning one where the aim of computation becomes the recovery of the set of parameters that allow for the image spectra to be projected onto a set of graph vertices defined a priori. Moreover, as a result of this treatment, the scene material prototypes can be recovered making use of a clustering algorithm applied to the parameter-set. This setting also allows, in a straightforward manner, for the visualisation of the spectra. We discuss the links between our method and self-organizing maps and illustrate the utility of the method as compared to other alternatives elsewhere in the literature.

4:20PM *Optimal Reduced Set for Sparse Kernel Spectral Clustering [#N-14171]*

Raghvendra Mall, Siamak Mehrkanoon, Rocco Langone and Johan Suykens, KU Leuven, Belgium

Kernel spectral clustering (KSC) solves a weighted kernel principal component analysis problem in a primal-dual optimization framework. It results in a clustering model using the dual solution of the problem. It has a powerful out-of-sample extension property leading to good clustering generalization w.r.t. the unseen data points. The out-of-sample extension property allows to build a sparse model on a small training set and introduces the first level of sparsity. The clustering dual model is expressed in terms of non-sparse kernel expansions where every point in the training set contributes. The goal is to find reduced set of training points which can best approximate the original solution. In this paper a second level of sparsity is introduced in order to reduce the time complexity of the computationally expensive out-of-sample extension. In this paper we investigate various penalty based reduced set techniques including the Group Lasso, L0, L1+L0 penalization and compare the amount of sparsity gained w.r.t. a previous L1 penalization technique. We observe that the optimal results in terms of sparsity corresponds to the Group Lasso penalization technique in majority of the cases. We showcase the effectiveness of the proposed approaches on several real world datasets and an image segmentation dataset.

4:40PM *An Efficient Parallel ISODATA Algorithm Based on Kepler GPUs [#N-14183]*

Shiquan Yang, Jianqiang Dong and Bo Yuan, Tsinghua University, China

ISODATA is a well-known clustering algorithm based on the nearest neighbor rule, which has been widely used in various areas. It employs a heuristic strategy allowing the clusters to split and merge as appropriate. However, since the volume of the data to be clustered in the real world is growing continuously, the efficiency of the serial ISODATA has become a serious practical issue. The GPU (Graphics Processing Unit) is an emerging high performance computing platform due to its highly parallel multithreaded architecture. In this paper, we propose an efficient parallel ISODATA algorithm based on the latest Kepler GPUs and the dynamic parallelism feature in CUDA (Compute Unified Device Architecture). Performance study shows that our parallel ISODATA can achieve promising speedup ratios and features favorable scalability compared to the original algorithm.

5:00PM *Semi-Supervised Clustering with Pairwise and Size Constraints [#N-14301]*

Shaohong Zhang, Hau-San Wong and Dongqing Xie, Guangzhou University, China; City University of Hong Kong, Hong Kong

In recent years, semi-supervised clustering receives considerable attention in the pattern recognition and data mining communities. This type of clustering algorithms takes advantage of partial prior knowledge, and significant improved performance beyond traditional unsupervised clustering algorithms is observed. In general, the partial prior knowledge is mainly in the form of pairwise constraints, which specify whether point pairs should be in the same cluster or in different clusters. Moreover, some other forms of constraints also attract research interests, for example, the balance constraint or the size constraint. However, it is also important to consider different types of constraints simultaneously, since different types of prior knowledge might have their own bias when considered separately. In this paper, we propose an improved algorithm to incorporate the pairwise and size constraints into a unified framework. Experiments on several benchmark data sets demonstrate that the proposed unified algorithm outperforms previous approaches under a variety of different conditions, which demonstrates that judicious integration of different types of constraints can result in improved performance than in those cases where only a single kind of constraint is used.

5:20PM *Multivariate Multi-Scale Gaussian for Microarray Unsupervised Classification [#N-14706]*

Amelia King, Zihua Yang and ZhengRong Yang, University of Exeter, United Kingdom; University of Queen Mary, United Kingdom

unsupervised classification has been one of the most popular machine learning approaches used in biological data analysis. Microarray gene expression data is an important data source for biological investigations. The simplest statistical/machine learning approach is to predict differentially expressed genes, which is a two-class unsupervised classification process. When there are only two experimental conditions, t test or modified t test are the matured approaches to solve the problem. However when there are more than two experimental conditions, t test or modified t test can only be used to predict homogeneously differentially expressed genes, not heterogeneously differentially expressed genes. A homogeneously differentially expressed gene shows the same regulation direction across multiple stages. A heterogeneously differentially expressed genes shows different regulation directions across multiple stages. Multivariate unsupervised classification is then an option. Bayesian clustering algorithm (mclust) has been widely used for unsupervised classification of biological data. However it is extremely slow and is less reliable when the number of statges is small. Here we introduce a similar machine learning algorithm referred to as multivariate multi-scale Gaussian (MSG) as an alternative to mclust. We show that MSG is more accurate and faster. We have validated MSG using both simulated and real data.

5:40PM *Hierarchical Linear Dynamical Systems: A New Model for Clustering of Time Series [#N-14761]*

Goktug Cinar, Carlos Loza and Jose Principe, University of Florida, United States

The auditory cortex in the brain does effortlessly a better job of extracting information from the acoustic world than our current generation of signal processing algorithms. The proposed architecture, Hierarchical Linear Dynamical System (HLDS), is based on Kalman filters with hierarchically coupled state models that stabilize the input dynamics and provide a representation space. This approach extracts information from the input and self-organizes it in the higher layers leading to an algorithm capable of clustering time series in an unsupervised manner. In this paper we further investigate the properties of HLDS, demonstrate its performance on music

rather than isolated notes and propose the time domain implementation to overcome one of its current bottlenecks.

WeN2-6 Dynamics of Neural Systems

Wednesday, July 9, 4:00PM-6:00PM, Room: 305E, Chair: Zhanshan Wang

4:00PM *A Review on Evolution of Lyapunov-Krasovskii Function in Stability Analysis of Recurrent Neural Networks with Single Time-Varying Delay [#N-14270]*

Zhanshan Wang, Zhenwei Shen, Mi Tian and Qihe Shan, Northeastern University, China

In the stability analysis of recurrent neural networks, one of the tasks is to reduce the conservativeness of the stability criterion. Along this routine, there are two ways to be considered. One is how to construct the Lyapunov-Krasovskii functional (LKF), and the other is how to use mathematical skills to estimate the derivatives of the LKF. The purpose of this paper is to present a brief review on the evolution on the construction of LKF for recurrent neural networks with single time-varying delay. By summarizing the observation, one can find the core elements in the construction of LKF. Moreover, one can find the evolution history on the delay-partitioning and its applications in the construction of LKF.

4:20PM *Stability of Hopfield Neural Networks with Event-Triggered Feedbacks [#N-14324]*

Xinlei Yi, Wenlian Lu and Tianping Chen, Fudan University, China

This paper investigates the convergence of Hopfield neural networks with an event-triggered rule to reduce the frequency of the neuron output feedbacks. The output feedback of each neuron is based on the outputs of its neighbours at its latest triggering time and the next triggering time of this neuron is determined by a criterion based on its neighborhood information as well. It is proved that the Hopfield neural networks are completely stable under this event-triggered rule. The main technique of proof is to prove the finiteness of trajectory length by the ${\L}$ojasiewicz inequality. The realization of this event-triggered rule is verified by the exclusion of Zeno behaviors. Numerical examples are provided to illustrate the theoretical results and present the goal-seeking capability of the networks. Our result can be easily extended to a large class of neural networks.

4:40PM *Nonlinear Responses of an Asynchronous Cellular Automaton Model of Spiral Ganglion Cells [#N-14359]*

Masato Izawa and Hiroyuki Torikai, Osaka University, Japan; Kyoto Sangyo University, Japan

The mammalian cochlear consists of nonlinear components: lymph (viscous fluid), a basilar membrane (vibrating membrane), outer hair cells (active dumpers), inner hair cells (neural transducers), and spiral ganglion cells (parallel spikes density modulators). In this paper, a novel spiral ganglion cell model based on an asynchronous sequential logic is presented. It is shown that the presented model can reproduce typical nonlinear responses of the spiral ganglion cell, e.g., spontaneous spiking, parallel spike density modulation, and adaptation. Also, FPGA experiments validate the reproductions of the nonlinear responses by the presented model.

5:00PM *New Method on the Complete Stability of Delayed Cellular Neural Networks [#N-14441]*

Lili Wang and Tianping Chen, Shanghai University of Finance and Economics, China; Fudan University, China

In this paper, a class of delayed cellular neural networks are investigated. Besides the coexistence of multiple equilibrium points and their multistability, we are concerned with the complete stability of these dynamical systems. And by rigorous analysis, it concludes that every solution trajectory would converge to one of the equilibrium points despite of the time-varying delays, that is, the delayed cellular neural networks are completely stable.

5:20PM *Reproduction of Forward and Backward Propagations on Dendrites by Multi-Compartment Asynchronous Cell Automaton Neuron [#N-14623]*

Naoki Shimada and Hiroyuki Torikai, Osaka University, Japan; Kyoto Sangyo University, Japan

The neuron is roughly divided into three parts: soma, dendrite, and an axon. In this paper, a multi-compartment neuron model the dynamics of which is described by an asynchronous cellular automaton is presented. It is shown that the model can reproduce typical propagations of action potentials from dendrites to a soma (forward propagation) and from a soma to dendrites (backward propagation).

5:40PM *Phase Cone Detection Optimization in EEG Data [#N-14793]*

Mark Myers, Robert Kozma and Roman Ilin, University of Tennessee Health Science Center, United States; University of Memphis, United States; Wright Patterson Air Force Base, United States

Signals measured by electroencephalogram (EEG) arrays were decomposed using Hilbert Transformations to produce the spatial amplitude and phase modulation (AM and PM) patterns. Spatial PM patterns intermittently exhibit synchronization-desynchronization transitions. During desynchronization, the spatial PM patterns intermittently conform to conic shapes. These phase cones mark the onset of emergent AM patterns, which carry cognitive content. In this work, various temporal band pass filters were applied to study the frequency dependence of phase cones in the beta-gamma range (10-40 Hz). The results are interpreted in the context of the cognitive cycle of knowledge generation.

Industrial Session: WeN2-7 CI on Smart Grid and Energy Efficiency

Wednesday, July 9, 4:00PM-6:00PM, Room: 303, Chair: Marco Mussetta and Timothy Havens

4:00PM *Fault Recognition in Smart Grids by a One-Class Classification Approach [#N-14472]*

Enrico De Santis, Lorenzo Livi, Alireza Sadeghian and Antonello Rizzi, Sapienza University of Rome, Italy; Ryerson University, Canada

Due to the intrinsic complexity of real-world power distribution lines, which are highly non-linear and time-varying systems, modeling and predicting a general fault instance is a very challenging task. Power outages can be experienced as a consequence of a multitude of causes, such as damage of some physical components or grid overloads. Smart grids are equipped with sensors that enable continuous monitoring of the grid status, hence allowing the realization of control systems related to different optimization tasks, which can be effectively faced by Computational Intelligence techniques. This paper deals with the problem of faults modeling and recognition in a real-world smart grid, located in the city of Rome, Italy. It is proposed a suitable classication system able to recognize faults on medium voltage feeders. Due to the nature of the available data, the one-class classication framework is adopted. Experiments are presented and discussed considering a threeyear period of measurements of fault events gathered by ACEA Distribuzione

S.p.A., the company that manages the smart grid system under analysis. Results demonstrate the effectiveness and validity of our approach.

4:20PM *Hybrid Model Analysis and Validation for PV Energy Production Forecasting [#N-14655]*

Alessandro Gandelli, Francesco Grimaccia, Sonia Leva, Marco Mussetta and Emanuele Ogliari, Politecnico di Milano, Italy

In this paper a forecasting method for the Next Day's energy production forecast is proposed with respect to photovoltaic plants. A new hybrid method PHANN (Physical Hybrid Artificial Neural Network) based on Artificial Neural Network (ANN) and basic Physical constraints of the PV plant, is presented and compared with an ANN standard method. Furthermore, the accuracy of the two methods have been studied in order to better understand the intrinsic error committed by the PHANN, reporting some numerical results. This computing-based hybrid approach is proposed for PV energy forecasting in view of optimal usage and management of RES in future smart grid applications.

4:40PM *Personalized Sensing towards Building Energy Efficiency and Thermal Comfort [#N-14943]*

Huafen Hu, Yonghong Huang, Milan Milenkovic, Chad Miller and Ulf Hanebutte, Portland State University, United States; Intel Labs, United States; Intel Federal, United States

The emergence of Information Technology (IT) based sensing has received increasing attention and acceptance in buildings due to its noninvasive nature and its ability in delivering real-time and potentially highly personalized feedback to building energy and comfort management. This study presents results of a pilot deployment experiment on such an IT-based sensing system - Personal Office Energy Monitor (POEM) developed by Intel Labs. The pilot study shows that with appropriate analytic methods the POEM sensor data could be transferred into valuable inputs to building management system (BMS). This study applies building science principle based models as the first step to calculate intermediate building performance indices based on raw measurement data. The intermediate performance indices are then further analyzed in order to reveal potential means to improve a building's operational energy efficiency and occupant comfort. Results demonstrate that POEM sensor data could lead to energy saving opportunities through localized comfort management, plug load sensing and scheduling, and occupancy based building control. As an IT platform-integrated and occupant centered sensing system, POEM provides a convenient, low-cost, and efficient sensing solution to the next generation of smart buildings, featured by its ability in assisting BMS to improve operational building energy efficiency without compromising occupants' thermal comfort and indoor environmental quality.

5:00PM *A Supervised Approach to Electric Tower Detection and Classification for Power Line Inspection [#N-14732]*

Carlos Sampedro, Carol Martinez, Aneesh Chauhan and Pascual Campoy, Universidad Politecnica de Madrid, Spain

Inspection of power line infrastructures must be periodically conducted by electric companies in order to ensure reliable electric power distribution. Research efforts are focused on automating the power line inspection process by looking for strategies that satisfy the different requirements of the inspection: simultaneously detect transmission towers, check for defects, and analyze security distances. Following this direction, this paper proposes a supervised learning approach for solving the tower detection and classification problem, where HOG (Histograms of Oriented Gradients) features are used to train two MLP (multi-layer perceptron) neural networks. The first classifier is used for background-foreground segmentation, and the second multi-class MLP is used for classifying within 4 different types of electric towers. A thorough evaluation of the tower detection and classification approach has been carried out on image data from real inspections tasks with different types of towers and backgrounds. In the different evaluations, highly encouraging results were obtained. This shows that a learning-based approach is a promising technique for power line inspection.

5:20PM *Random Forest Based Adaptive Non-Intrusive Load Monitoring [#N-14815]*

Jie Mei, Dawei He, Ronald Harley and Thomas Habetler, Georgia Institute of Technology, United States

Non-intrusive load monitoring (NILM) is a load monitoring technique proposed to use in today's residential energy auditor. It is expected to automatically provide the information of the type, energy consumption, and operation status of the electric loads without getting access to the loads. However, there still not exists any commercialized product so far, mainly because of the extraordinary large load sets comparing with the limited learning data. The fast emerging of new types of loads further aggravates the problem. This paper proposes an adaptive non-intrusive load identification model to address this problem. The proposed model is not dedicated to identify all the loads around the world, but it will grasp knowledge from samples that are not identified in the real application, and gradually form a new learning procedure so as to identify more and more new samples correctly. Random forest algorithm is introduced here to realize the objective and a case study is carried out to verify the effectiveness of the model.

5:40PM *Fuzzy Logic Controller for Energy Management of Power Split Hybrid Electric Vehicle Transmission [#F-14387]*

Varun Navale and Timothy Havens, Michigan Technological University, United States

This paper investigates energy management strategies for a power split hybrid electric transmissions using a fuzzy design method. Hybrid Electric Vehicles (HEV) is one of the most promising research topics for developing efficient and environmentally-friendly transportation solutions. A power split hybrid combines the advantages of both series and parallel hybrid configurations by providing a higher degree of freedom to fulfill the demand of the driver while improving overall fuel efficiency at the cost of higher complexity and non-linearity in the control system design. There are two issues that should be addressed for energy management: torque distribution and battery charge sustenance. The fuzzy controller controls the torque request for the internal combustion engine by taking into consideration the vehicle speed, battery state-of-charge, and the normalized torque request from either the driver or an automated driving controller. The controller has several rules to control the internal combustion engine (ICE) torque request. We show that our rule base provides greater control over the ICE operation over a wide range of conditions for optimum fuel consumption. The controller was tested by integrating with a vehicle model and simulated by running it for multiple United States Environmental Protection Agency drive-cycles and then compared to a controller based on a commercially available HEV system.

Special Session: WeC2-1 CIS and WCCI Competition Session

Wednesday, July 9, 4:00PM-6:00PM, Room: 311A, Chair: Swagatam Das and Alessandro Sperduti

4:00PM *IEEE CIS Ghosts Challenge 2013*
Alessandro Sperduti, University of Padova, Italy

The challenge consists in developing an autonomous agent able to successfully play Geister (a game with partially observable information). Alessandro Sperduti will talk about this competition's progress and results.

4:45PM *Evolutionary Computation for Dynamic Optimization Problems*
Changhe Li, Michalis Mavrovouniotis, Shengxiang Yang and Xin Yao, China University of Geosciences, China; De Montfort University, United Kingdom; University of Birmingham, United Kingdom

This competition focuses on the real-parameter (continuous) dynamic function optimization problems along with a dynamic combinatorial optimization problem. The organizers will use the revised version of the benchmark DOPs (Dynamic Optimization Problems) in continuous space used for the 2009 and 2012 Competitions under the IEEE CEC for DOPs and a Dynamic Travelling Salesman Problem in combinatorial space as the benchmark DOPs.

5:10PM *Optimization of Problems with Multiple Interdependent Components*
Sergey Polyakovskiy, Markus Wagner, Mohammad Reza Bonyadi, Frank Neumann and Zbignew Michalewicz, The University of Adelaide, Australia; The University of Adelaide, Austria

The competition provides a platform for comparing computational intelligence approaches to solve multi-component optimization problems. The organizers mainly focus on the combination of the TSP and the Knapsack problems in this context. In particular, Euclidian 2D Travelling Salesperson instances are combined with 0-1- Knapsack instances in such a way that it reflects characteristics of the real- world problems; for example, the total weight of the items in the knapsack influences the travel speed of a traveler.

5:35PM *First Neural Connectomics Challenge: From Imaging to Connectivity*
Demian Battaglia, Max Planck Institute for Dynamics and Self-Organization, Germany

This competition aims at advancing the research on network structure reconstruction algorithms from neurophysiological data, including causal discovery methods. The challenge will make use of realistic simulations of real networks of neurons observed via calcium fluorescence recordings. The participants are expected to come up with efficient algorithms for analyzing time series and large data-sets. List of organizers: Isabelle Guyon, Olav Stetter, Demian Battaglia, Javier Orlandi, Jordi Soriano Fradera, Mehreen Saeed, Alexander Statnikov, Bisakha Ray, Alice Guyon, Gavin Cawley, Gideon Dror, Hugo-Jair Escalante, Vincent Lemaire, Sisi Ma, Florin Popescu, and Joshua Vogelstein.

Thursday, July 10, 1:30PM-3:30PM

Special Session: ThN1-1 Architectures and Theories of the Brain

Thursday, July 10, 1:30PM-3:30PM, Room: 308, Chair: Asim Roy

1:30PM *Reliable Object Recognition by Using Cooperative Neural Agents [#N-14085]*
Oscar Chang, Universidad Central de Venezuela, Venezuela

An artificial vision system based upon known insect brain structures is presented. It reliably recognizes real world objects visualized through a web cam or read from databases, and utilizes neural agents that communicate through time stabilized sparse code. A three layer ANN is trained to track one reticle pattern. Once trained the net becomes a proactive agent by participating in a local, close loop control system which oscillates, shows a sturdy emergent tracking behavior and produces a continuous flow of space-time related unstable code. This flow is time stabilized, converted to sparse form and relayed to a population of other isolated neural agents, whose response can be tuned to complex visual stimulus. Finally a novel noise-balanced training method is used to tune agents' response in and secluded environment, where only the images of a chosen object and noise exist. Isolation creates a strong agent-object association that boosts object recognition. The found solutions sustain sparse code, visual invariance and concentrate their decision into a single neuron. These might represents good start up conditions for modeling concept cells. The system has been tested using real time real world images and data bases.

1:50PM *A Nonlinear Model of fMRI BOLD Signal Including the Trend Component [#N-14437]*
Takashi Matsubara, Hiroyuki Torikai, Tetsuya Shimokawa, Kenji Leibnitz and Ferdinand Peper, Osaka University, Japan; Kyoto Sangyo University, Japan; National Institute of Information and Communications Technology and Osaka University, Japan

This paper presents a nonlinear model of the human brain activity response to visual stimuli according to Blood-Oxygen-Level-Dependent (BOLD) signals scanned by functional Magnetic Resonance Imaging (fMRI). A BOLD signal usually contains a low frequency signal component (trend), which is often ignored by the existing models or removed by approximation methods. However, such detrending could also destroy the dynamics of the BOLD signal and miss an important response. This paper shows a model that, in the absence of detrending, can predict the BOLD signal with smaller errors than existing models. For detrending, the presented model has also a lower Schwarz information criterion than existing models, which implies that the presented model will be less likely to overfit the experimental data.

2:10PM *How Might the Brain Represent Complex Symbolic Knowledge? [#N-14462]*
Ben Goertzel, Novamente LLC, United States

A novel category of theories is proposed, providing a potential explanation for the representation of complex knowledge in the human (and, more generally, mammalian) brain. Firstly, a "glocal" representation for concepts is suggested, involving a localized representation in a sparse network of "concept neurons" in the Medial Temporal Lobe, coupled with a complex dynamical attractor representation elsewhere in cortex. Secondly, it is hypothesized that a combinatory logic like representation is used to encode abstract relationships without explicit use of variable bindings, perhaps using systematic asynchronization among concept neurons to indicate an analogue of the combinatory-logic operation of function application. While unraveling the specifics of the brain's knowledge representation mechanisms will require data beyond what is currently available, the approach presented here provides a class of possibilities that is neurally plausible and bridges the gap between neurophysiological realities and mathematical and computer science concepts.

2:30PM *Statistical Approach for Reconstruction of Dynamic Brain Dipoles Based on EEG Data [#N-14464]*

Petia Georgieva, Filipe SIlva, Lyudmila Mihaylova and Nidhal Bouaynaya, University of Aveiro, Portugal; University of Sheffield, United Kingdom; Rowan University, United States

In this paper, we propose a statistical approach to reconstruct the brain neuronal activity based only on recorded EEG data. The brain zones with the strongest activity are expressed at a macro level by a few number of active brain dipoles. Normally, for solving the EEG inverse problem, fixed dipole locations are assumed, independently of the different stimuli that excite the brain. The proposed particle filter (PF) framework presents a shift in the current paradigm by estimating dynamic brain dipoles, which may vary from one location to another in the brain depending on internal/external stimuli that may affect the brain. Also, in contrast to previous solutions, the proposed PF algorithm estimates simultaneously, the number of the active dipoles, their moving locations and their respective oscillations in the three dimensional head geometry.

2:50PM *Design of the First Neural Connectomics Challenge: From Imaging to Connectivity [#N-14841]*

Isabelle Guyon, Demian Battaglia, Alice Guyon, Javier Orlandi, Mehreen Saeed, Jordi Soriano Fradera, Alexander Statnikov and Olav Stetter, ChaLearn, United States; University of Marseille, France; CNRS, France; University of Barcelona, Spain; University of Pakistan, Pakistan; New York University, United States; Max Planck Institute, Germany

We are organizing a challenge to reverse engineer the structure of neuronal networks from patterns of activity recorded with calcium fluorescence imaging. Unraveling the brain structure at the neuronal level at a large scale is an important step in brain science, with many ramifications in the comprehension of animal and human intelligence and learning capabilities, as well as understanding and curing neuronal diseases and injuries. However, uncovering the anatomy of the brain by disentangling the neural wiring with its very fine and intertwined dendrites and axons, making both local and far reaching synapses, is a very arduous task: traditional methods of axonal tracing are tedious, difficult, and time consuming. This challenge proposes to approach the problem from a different angle, by reconstructing the effective connectivity of a neuronal network from observations of neuronal activity of thousands of neurons, which can be obtained with state-of-the-art fluorescence calcium imaging. To evaluate the effectiveness of proposed algorithms, we will use data obtained with a realistic simulator of real neurons for which we have ground truth of the neuronal connections. We produced simulated calcium imaging data, taking into account a model of fluorescence and light scattering. The task of the participants is to reconstruct a network of 1000 neurons from time series of neuronal activities obtained with this model. This challenge is part of the official selection of the WCCI 2014 competition program.

3:10PM *A Bridge-Islands Model for Brains: Developing Numeric Circuits for Logic and Motivation [#N-14914]*

Juyang Weng, Michigan State University, United States

Neuroscience has made impressive advances, but there is a lack of an overall computational brain theory. I would like to present a simplified computational theory in an intuitive language about how the brain wires itself as a multi-interchange bridge that bi-directionally connects many islands where each island is a sensor or effector. The wiring process of the brain is highly self-supervised while a baby lives and acts in his physical environment, e.g., sucking a milk bottle. I use a new precise framework of emergent finite automata to explain how the brain develops its numeric circuits that can be clearly understood in terms of logic. I also explain how the self-wired basic circuits become motivated through four additional neural transmitters beyond glutamate and GABA --- serotonin, dopamine, acetylcholine, and norepinephrine. I use finite automata for precise and rigorous analysis and optimality.

Special Session: ThN1-2 Hybrid Neural Intelligent Systems

Thursday, July 10, 1:30PM-3:30PM, Room: 305A, Chair: Patricia Melin

1:30PM *Selecting and Combining Models with Self-Organizing Maps for Long-Term Forecasting of Chaotic Time Series [#N-14147]*

Rigoberto Fonseca-Delgado and Pilar Gomez-Gil, National Institute of Astrophisics, Optics and Electronics, Mexico

When time series are generated by chaotic systems, a reasonable estimation of large prediction horizons is hard to obtain, but this may be required by some applications. Over the last years, some researchers have focused on the use of ensembles and meta-learning as a strategy for improving prediction accuracy. This paper addresses the problem of selecting and combining models for the design of efficient long-term predictors of chaotic time series based on meta-learning and self-organization. We propose and evaluate the use of four heuristic rules for selecting models using a self-organizing map (SOM) neural network and meta-features. The meta-features are extracted from the performances of each involved model when applied to the training time series. A trained SOM map, which was generated using these meta-features, allows the selection of models with diverse behaviors. Two strategies for the combination of models are compared; one is based on the average and a second is based on the median of the forecasts of the selected models. The experiments were executed using four types of series: the time series dataset provided by the NN5 tournament and time series generated from the Mackey-Glass equation, from an ARIMA model and from a sine function. In most cases, the best results were obtained using a percentage of the models belonging to the group that contained the best model. Our results also showed that a combination using a median strategy obtained better results that using an average strategy.

1:50PM *Impulsive Synchronization of Coupled Switched Neural Networks with Impulsive Time Window [#N-14208]*

Xin Wang, Chuandong Li, Tingwen Huang and Xiaofeng Liao, Southwest University, China; Texas A and M University at Qatar, Qatar

This paper formulates and studies a more general model of coupled switched neural networks with impulsive time window. The main feature of impulsive time window is that impulses can exist the stochastic instants of the whole switching interval not the switching instants and a pre-specified instants. Moreover, the impulsive numbers of every subsystems is not the same. Using switching Lyapunov functions and a generalized Halany inequality, some general criteria which characterize the impulses and switching effects in aggregated form, for asymptotically synchronization and exponential synchronization of this general model are established.

2:10PM *Vibrate Synchronizing Function Neural Network Model - Its Backgrounds [#N-14891]*

Yoshitsugu Kakemoto and Shinichi Nakasuka, JSOL Corp, Japan; The University of Tokyo, Japan

VSF-Network, Vibrate Synchronizing Function Network, is a hybrid neural network combining a Chaos Neural Network with a hierarchical network. VSF-Network is designed for symbol learning by a neural network. It finds unknown parts of input data by comparing to learned pattern and it learns unknown patterns using unused part of the network. The new patterns are learned incrementally and they are represented as sub-networks with unused parts of hierarchical neural network. Combinations of patterns are represented as combinations of the sub-networks. The combinations of symbols are represented as combinations of the sub-networks. In this paper, the two theoretical backgrounds of VSF-Network are introduced. At the first, an incremental learning framework with Chaos Neural Networks is introduced. Next, the pattern recognition with the combined with symbols is introduced. By Stochastic Catastrophe Model, the authors explain the combined pattern recognition. Through an experiment, both the incremental learning capability and the pattern recognition with pattern combination.

2:30PM *Neural Networks for Runtime Verification [#N-14929]*

Alan Perotti, Artur d'Avila Garcez and Guido Boella, University of Turin, Italy; City University London, United Kingdom

A recent trend in High-Performance Computation is parallel computing, and the field of Neural Networks is showing impressive improvements in performance, especially with the use of GPU accelerators. In this paper, we use neural networks to improve the performance of Runtime Verification. Runtime verification is used in a variety of domains -from policy enforcement to electronic fraud detection- to automatically check whether a system meets a temporal specification, by observing the output of the system. In this paper, we present a novel run-time monitoring system, RuleRunner, and we exploit results from the Neural-Symbolic Integration area to encode it in a recurrent neural network. The results show that neural networks can perform real-time online runtime verification. Performance was improved by the parallel architecture and the matrix-based implementation with GPU.

Special Session: ThN1-3 Ensemble Systems and Machine Learning

Thursday, July 10, 1:30PM-3:30PM, Room: 305B, Chair: Marley Vellasco and Teresa Ludermir

1:30PM *Towards Generating Random Forests via Extremely Randomized Trees [#N-14279]*

Le Zhang, Ye Ren and P. N. Suganthan, NanYang technological University, Singapore

The classification error of a specified classifier can be decomposed into bias and variance. Decision tree based classifier has very low bias and extremely high variance. Ensemble methods such as bagging can significantly reduce the variance of such unstable classifiers and thus return an ensemble classifier with promising generalized performance. In this paper, we compare different tree-induction strategies within a uniform ensemble framework. The results on several public datasets show that random partition (cut-point for univariate decision tree or both coefficients and cut-point for multivariate decision tree) without exhaustive search at each node of a decision tree can yield better performance with less computational complexity.

1:50PM *Reservoir Computing Optimization with a Hybrid Method [#N-14493]*

Anderson Sergio and Teresa Ludermir, Federal University of Pernambuco, Brazil

Reservoir Computing (RC) is a paradigm of artificial neural networks with important applications in the real world. RC uses similar architecture to recurrent networks without the difficulty of training the network hidden layer (reservoir). However, RC can be computationally expensive and various parameters influence its efficiency, making it necessary to search for alternatives to increase its capacity. This work aims to use a hybrid algorithm between a PSO (Particle Swarm Optimization) extension and Simulated Annealing for optimize the global parameters, architecture and weights of RC, in time series forecasting. The results showed that the Reservoir Computing optimization with the hybrid algorithm achieved satisfactory performance in all databases investigated and outperformed original APSO (Adaptive Particle Swarm Optimization) in some of them.

2:10PM *An Empirical Analysis of Ensemble Systems in Cancellable Behavioural Biometrics: A Touch Screen Dataset [#N-14708]*

Marcelo Damasceno de Melo and Anne Canuto, Federal Institute of Rio Grande do Norte, Brazil; Federal University of Rio Grande do Norte, Brazil

This paper presents an experimental analysis of a revocable biometric verification problem using ensemble systems. Behavioural Biometric-based systems are a future emergent area on identification, verification and access control systems of users. However, there is still progress to be done in this field, specially related to system security and acceptable results for practical use. Cancellable Biometrics is a alternative solution to the security problem of biometric data. This technique consists of applying transformation functions to biometric data in order to protect the original characteristics of biometric template. In this case, if biometric template has compromised, a new representation of original biometric data can be generated. Although cancellable biometrics were proposed to solve privacy concerns, this concept raises new issues, becoming the authentication problem more complex and difficult to solve. Thus, more effective authentication structures are needed to perform these tasks. This work aims to investigate the use of ensemble systems in cancellable behavioural biometric system used by million people (touchscreen devices). Apart this, we also present an empirical analysis, comparing the ensemble structures with single classification algorithms.

2:30PM *Ensemble Learning for Keyword Extraction from Event Descriptions [#N-14835]*

Pedro Geadas, Ana Alves and Bernardete Ribeiro, CISUC, Portugal

Automatic keyword extraction (AKE) from textual sources took a valuable step towards harnessing the problem of efficient scanning of large document collections. Particularly in the context of urban mobility, where the most relevant events in the city are advertised on-line, it becomes difficult to know exactly what is happening in a place. In this paper we tackle this problem by extracting a set of keywords from different kinds of textual sources, focusing

on the urban events context. We propose an ensemble of automatic keyword extraction systems KEA (Keyphrase Extraction Algorithm) and KUSCO (Knowledge Unsupervised Search for instantiating Concepts on lightweight Ontologies) and Conditional Random Fields (CRF). Unlike KEA and KUSCO which are well-known tools for automatic keyword extraction, CRF needs further preprocessing. Therefore, a tool for handling AKE from the documents using CRF is developed. The architecture for the AKE ensemble system is designed and efficient integration of component applications is achieved. Finally, we empirically show that our AKE ensemble system significantly succeeds on baseline sources and urban events collections.

2:50PM *Ensembles Of Evolutionary Extreme Learning Machines through Differential Evolution and Fitness Sharing [#N-14919]*

Tiago Lima and Teresa Ludermir, Universidade Federal de Pernambuco, Brazil

Extreme Learning Machine (ELM) is a single-hidden-layer feedforward neural network which has been applied into many real world pattern classification problems. Recently, ELMs have been built in an automatic way through evolutionary algorithms. Most works, nonetheless, do not uses all population obtained, but choose only one individual in the last generation. In an attempt to improve performance, an ensemble is a more promising choice because a pool of classifiers might produce higher accuracy than merely using the information from only one classifier among them. One of the most important factors for optimum accuracy is the diversity of the classifier pool. In this work, an enhanced Differential Evolution incorporating sharing function method is used to generate a pool of ELMs. Fitness Sharing that shares resources if the distance between the individuals is smaller than the sharing radius is a representative specification method, which produces diverse results than standard evolutionary algorithms that converge to only one solution. Experimental results on 14 well known benchmark classification tasks suggest that our method can generate ensembles that are more effective than ensembles solely through DE and traditional ensemble methods.

ThN1-4 Reinforcement and Hybrid Learning

Thursday, July 10, 1:30PM-3:30PM, Room: 305C, Chair: Huaguang Zhang

1:30PM *Unmanned Aerial Vehicles (UAV) Heading Optimal Tracking Control Using Online Kernel-Based HDP Algorithm [#N-14024]*

Fuxiao Tan, Derong Liu, Xinping Guan and Bin Luo, Fuyang Teachers College, China; Institute of Automation, Chinese Academy of Sciences, China; Shanghai Jiao Tong University, China; Anhui University, China

UAV can work in the places where are dangerous, or not easy to reach by humans. UAV expends the potential value of UAV in application. However, due to the active control and operating difficulties, it is still a challenge to develop fully autonomous flight in complex environment. This paper applies a novel heuristic dynamic programming for the UAV heading optimal tracking controller design, that is kernel-based HDP. Kernel-based HDP is developed by integrating kernel methods and approximately linear dependence (ALD) analysis with the critic learning of HDP algorithm. Compared with conventional HDP where neural networks are widely used and their features was manually designed, the proposed algorithm can obtain better generalization capability and learning efficiency through applying the sparse kernel machine into the critic learning process of HDP algorithm. Simulation and experimental results of UAV heading optimal tracking control problems demonstrate the effectiveness of the proposed kernel- based HDP algorithm.

1:50PM *Scalarization-Based Pareto Optimal Set of Arms Identification Algorithms [#N-14194]*

Madalina Drugan and Ann Nowe, Artificial Intelligence Lab, Vrije Universiteit Brussels, Belgium

Multi-objective multi-armed bandits (MOMAB) is an extension of the multi-objective multi-armed bandits framework that considers reward vectors instead of scalar reward values. Scalarization functions transform the reward vectors into reward values in order to use the standard multi-armed bandits (MAB) algorithms. However for many applications it is not obvious to come up with a good scalarization set and therefore there is needed to develop MAB that discover the whole Pareto set of arms. Our approach to this multi-objective MAB problem is two folded: i) identify the set of Pareto optimal arms and ii) identify the minimum subset of scalarization functions that optimize the set of Pareto optimal arms. We experimentally compare the proposed MOMAB algorithms on a multi-objective Bernoulli problem.

2:10PM *Approximate Model-Assisted Neural Fitted Q-Iteration [#N-14564]*

Thomas Lampe and Martin Riedmiller, Albert-Ludwigs-University Freiburg, Germany

In this work, we propose an extension to the Neural Fitted Q-Iteration algorithm that utilizes a learned model to generate virtual trajectories which are used for updating the Q-function. Compared to standard NFQ, this combination has the potential to greatly reduce the amount of system interaction required to learn a good policy. At the same time, the approach still maintains the generalization ability of Q-learning. We provide a general formulation for approximate model-based fitted Q-learning, and examine the advantages of its neural implementation regarding interaction time and robustness. Its capabilities are illustrated with first results on a benchmark cart-pole regulation task, on which our method turns out to provide more general policies using much less interaction time.

2:30PM *Explore to See, Learn to Perceive, Get the Actions for Free: SKILLABILITY [#N-14651]*

Varun Kompella, Marijn Stollenga, Matthew Luciw and Juergen Schmidhuber, IDSIA, Switzerland

How can a humanoid robot autonomously learn and refine multiple sensorimotor skills as a byproduct of curiosity driven exploration, upon its high-dimensional unprocessed visual input? We present SKILLABILITY, which makes this possible. It combines the recently introduced Curiosity Driven Modular Incremental Slow Feature Analysis (Curious Dr. MISFA) with the well-known options framework. Curious Dr. MISFA's objective is to acquire abstractions as quickly as possible. These abstractions map high-dimensional pixel-level vision to a low dimensional manifold. We find that each learnable abstraction augments the robot's state space with new information about the environment, for example, when the robot is grasping a cup. The abstraction is a function on an image, called a slow feature, which can effectively discretize a high-dimensional visual sequence. For example, it maps the sequence of the robot watching its arm as it moves around, grasping randomly, into a step function having two outputs: when the cup is or is not currently grasped. The new state space includes this information. Each abstraction is coupled with an option. The reward function for the option's policy (learned through LSPI) is high for transitions that produce a large change in the slow features. This corresponds to finding bottleneck states, which are known good subgoals for hierarchical reinforcement learning - in the example, the subgoal corresponds to grasping the cup. The final skill includes both the learned policy and the learned abstraction. SKILLABILITY makes our iCub the first humanoid robot to learn complex skills such as to topple or grasp an object, from raw high- dimensional video input, driven purely by its intrinsic motivations.

2:50PM *Correntropy Kernel Temporal Differences for Reinforcement Learning Brain Machine Interfaces [#N-14922]*

Jihye Bae, Luis Sanchez Giraldo, Joseph Francis and Jose Principe, University of Florida, United States; SUNY Downstate Medical Center, United States

This paper introduces a novel temporal difference algorithm to estimate a value function in reinforcement learning. This is a kernel adaptive system using a robust cost function called correntropy. We call this system correntropy kernel temporal difference (CKTD). This algorithm is integrated with Q-learning to find a proper policy (Q-learning via correntropy kernel temporal difference). The proposed method was tested with a synthetic problem, and its robustness under a changing policy was quantified. The same algorithm was applied to the decoding of a monkey's neural state in a reinforcement learning brain machine interface (RLBMI) in a center-out reaching task. The results showed the potential advantage of the proposed algorithm in the RLBMI framework.

3:10PM *PROPRE: PROjection and PREdiction for Multimodal Correlations Learning. An Application to Pedestrians Visual Data Discrimination. [#N-14826]*

Mathieu Lefort and Alexander Gepperth, INRIA FOWERS, France

PROPRE is a generic and modular unsupervised neural learning paradigm that extracts meaningful concepts of multimodal data flows based on predictability across modalities. It consists on the combination of three modules. First, a topological projection of each data flow on a self-organizing map. Second, a decentralized prediction of each projection activity from each others map activities. Third, a predictability measure that compares predicted and real activities. This measure is used to modulate the projection learning so that to favor the mapping of predictable stimuli across modalities. In this article, we use Kohonen map for the projection module, linear regression for the prediction one and we propose multiple generic predictability measures. We illustrate the properties and performances of PROPRE paradigm on a challenging supervised classification task of visual pedestrian data. The modulation of the projection learning by the predictability measure improves significantly classification performances of the system independently of the measure used. Moreover, PROPRE provides a combination of interesting functional properties, such as a dynamical adaptation to input statistic variations, that is rarely available in other machine learning algorithms.

ThN1-5 Models of Perception, Cognition and Coordination

Thursday, July 10, 1:30PM-3:30PM, Room: 305D, Chair: Leonid Perlovsky

1:30PM *Pinning Dynamic Complex Networks by Time-Varying Controller-Vertex Set [#N-14404]*

Yujuan Han, Wenlian Lu and Tianping Chen, Fudan University, China

In this paper, we give a stability analysis of multi-agent system with a local pinning control algorithm for very general network topologies. These include determinately directed time varying topologies, the stochastically switching topologies. The pinned vertex set also varies with time, including deterministic and stochastic time-variations. We present sufficient conditions to guarantee the convergence of the pinning process: for the deterministic case, a time-varying pinned vertex set can stabilize the network of multi-agents with time-varying topologies if any vertex in the networks can be accessed by directed paths by at least one vertex in the pinned vertex set across all time intervals that are pre-defined; Similar results are also given for the stochastically switching case. As applications, numerical simulations based on the random waypoint model are given to verify our theoretical results.

1:50PM *Distributed LQR Design for Multi-Agent Systems on Directed Graph Topologies [#N-14487]*

Tao Feng, Huaguang Zhang, Yanhong Luo and Yingchun Wang, Northeastern University, China

In this paper, the inverse optimal approach is employed to design distributed cooperative control protocols for identical linear systems that guarantee consensus and global optimality with respect to a positive (semi-) definite quadric performance index. Cooperative control and pinning control problems are considered, where the communication graphs are assumed to be directed and have fixe topology. Simple sufficient conditions are established, which indicate that the global optimality is achieved using local distributed protocols which are designed by the linear quadric regulator (LQR) based optimal control method. Examples are given to show the effectiveness of the proposed methods.

2:10PM *Impact of Ratio k on Two-Layer Neural Network with Dynamic Optimal Learning Rate [#N-14634]*

Tong Zhang and C. L. Philip Chen, University of Macau, Macau

Learning process is an important part in two-layer networks. It is imperative to search for an optimal learning rate to get a maximum error reduction in each learning step. Related literature has proposed various kinds of methods to find such an optimal learning rate in the past decades. In this paper, we proposed an improved dynamic optimal learning rate by adding an optimal ratio k. It is found that our improved dynamic optimal learning rate can generate a better result in learning processes. Meanwhile, we have proved the existence of the ratio k by giving it a proper math expression. Furthermore, we also applied the improved learning rate to solve inverse problem and compared the difference of the improved learning rate with the previous approach. It is observed that our proposed method performs better. Therefore, it can be concluded that our new method to search for dynamic optimal learning rate is valuable in the intelligence learning applications of neural networks, or it is effective in the aspect of tested problem at least.

2:30PM *A Neural Model of Mentalization/Mindful Based Psychotherapy [#N-14812]*

Abbas Edalat and Lin Zheng, Imperial College London, United Kingdom

We introduce and implement a neural model for mentalization/mindfulness based psychotherapy. It uses Dan Levine's neural model of pathways for emotional-cognitive decision making, which is integrated with a competitive Hopfield network built up from the new concept of strong patterns for the six basic emotions and for mentalization or mindfulness. We adopt a particular form of Q-learning to reinforce the mentalizing/mindful pattern in the network, which represents the process of psychotherapy. In a successful course of therapy, the mentalizing/mindful pattern becomes the more dominant pattern compared to negative emotions and the brain makes decisions that are more deliberate and thoughtful than heuristic and automatic.

2:50PM *Incremental Face Recognition Using Rehearsal and Recall Processes [#N-14824]*
Sangwook Kim, Mallipeddi Rammohan and Lee Minho, Kyungpook National University, Korea, Republic of

Most of the machine learning algorithms particularly suffer from the plasticity-stability dilemma. In this paper, we propose a model that adopts two types of memories i.e. short-term memory (STM) and long-term memory (LTM), which share their information through control processes called rehearsal and recall to alleviate the dilemma. In addition, the proposed model tries to integrate the advantages of generative and discriminative classifiers by employing them in STM and LTM respectively. Experimental results show the importance of rehearsal and recall process in improving the performance of the algorithm.

3:10PM *On the Relationships Between Social Structures and Acquired Knowledge in Societies [#N-14939]*
Toshihiko Matsuka and Hidehito Honda, Chiba University, Japan; National Institute of Informatics, Japan

Many existing studies on human learning pay almost exclusive attention to how individuals learn. Unlike those studies, we examined influence of social structures on knowledge acquired by societies using computer simulations. We compared four types of social networks, namely regular, random, small world, and scale-free networks. When individual differences and the principle of homophily (i.e., people who have similar beliefs tend to have close relationships with each other) exist in societies, the societies would acquire pareto-optimal knowledge. We also investigated influences of highly connected individuals on knowledge acquired by societies. The results inarguably indicate that highly connected individuals play important roles in social learning, setting the standards for what type of knowledge to be acquired by societies.

ThN1-6 Recurrent Neural Networks

Thursday, July 10, 1:30PM-3:30PM, Room: 305E, Chair: Yunong Zhang

1:30PM *Case Study of Zhang Matrix Inverse for Different ZFs Leading to Different Nets [#N-14020]*
Dongsheng Guo, Binbin Qiu, Zhende Ke, Zhi Yang and Yunong Zhang, Sun Yat-sen University, China

This paper primarily demonstrates the effectiveness of the Z-type methodology for solving the problem of time-variant matrix inverse (termed Zhang matrix inverse, ZMI). As a case study of ZMI with examples, the online solution of ZMI is investigated in this paper. Specifically, different Zhang functions (ZFs), which lead to different effective Z-type models (i.e., Zhang neural nets), are proposed and implemented as the error basis functions for ZMI.Meanwhile, a specific relationship between the Z-type model and others' model/method [i.e., the Getz and Marsden (G-M) dynamic system] is presented. Eventually, the MATLAB Simulink modeling and simulative verifications with examples using such different Z-type models are further researched. Both theoretical analysis and modeling results demonstrate the efficacy of the proposed Z-type models which originate from different ZFs for ZMI.

1:50PM *Neurodynamics-Based Robust Eigenstructure Assignment for Second-Order Descriptor Systems [#N-14088]*
Xinyi Le, Zheng Yan and Jun Wang, the Chinese University of Hong Kong, Hong Kong

In this paper, a neurodynamic optimization approach is proposed for robust eigenstructure assignment problem of second-order descriptor systems via state feedback control. With a novel robustness measure serving as the objective function, the robust eigenstructure assignment problem is formulated as a pseudoconvex optimization problem. Two coupled recurrent neural networks are applied for solving the optimization problem with guaranteed optimality and exact pole assignment. Simulation results are included to substantiate the effectiveness of the proposed approach.

2:10PM *Oscillation Analysis of the Solutions for a Four Coupled FHN Network Model with Delays [#N-14226]*
Chunhua Feng and Rejean Plamondon, Guangxi Normal University, China; Ecole Polytechnique de Montreal, Canada

In this paper, the existence of oscillatory solutions for a four coupled FHN network model with delays is investigated. Some theorems to determine the oscillatory solutions for the system are obtained. The practical criteria for selecting the parameters in this network are provided. Computer simulations are also given to illustrate the effectiveness of the results.

2:30PM *Ideal Modified Adachi Chaotic Neural Networks and Active Shape Model for Infant Facial Cry Detection on Still Image [#N-14251]*
Yosi Kristian, Mochamad Hariadi and Mauridhi Hery Purnomo, Institut Teknologi Sepuluh Nopember, Indonesia

In this paper, we develop a pattern recognition system to detect weather an infant is crying or not just by using his facial feature. The system must first detect the baby face by using the Haar-like feature, then find the facial component using trained active shape model (ASM). The extracted feature then fed to Chaotic Neural Network Classifier. We designed the system so that when the testing pattern is not a crying baby the system will be chaotic, but when the testing pattern is a crying baby face the system must switch to being periodic. Predicting weather a baby is crying based only on facial feature is still a challenging problem for existing computer vision system. Although crying baby can be detected easily using sound, most CCTV don't have microphone to record the sound. This is the reason why we only use facial feature. Chaotic Neural Network (CNN) has been introduced for pattern recognition since 1989. But only recently that CNN receive a great attention from computer vision people. The CNN that we use in this paper is the Ideal Modified Adachi Neural Network (Ideal-M-AdNN). Experiments show that Ideal- M-AdNN with ASM feature able to detect crying baby face with accuracy up to 93%. But nevertheless this experiment is still novel and only limited to still image.

2:50PM *Three New ZNN Models with Economical Dimension and Exponential Convergence for Real-Time Solution of Moore-Penrose Pseudoinverse [#N-14289]*
Chen Peng, Yingbiao Ling, Ying Wang, Xiaotian Yu and Yunong Zhang, Sun Yat-sen University, China

Zhang neural network (ZNN) is a novel class of recurrent neural network with superior solution ability and convergence performance. For real-time solution of Moore-Penrose pseudoinverses of time-varying matrices based on continuous-time recurrent neural network, this paper proposes three different ZNN models, each of which is derived from a specifically-chosen Zhang function (ZF). Theoretical analyses guarantee the global convergence of the three different ZNN models and their fast convergence rate. Besides, the proposed ZNN models show additional great advantages when used to deal

with matrices with contrasting numbers of rows and columns. Computer simulations and experiments further verify the theoretical results, vividly demonstrating the effectiveness and efficiency of the proposed ZNN models.

3:10PM *A Recurrent Neural Network for Real Time Electrical Microgrid Prototype Optimization [#N-14912]*

Juan Diego Sanchez-Torres, Martin J. Loza-Lopez, Riemann Ruiz-Cruz, Edgar Sanchez and Alexander G. Loukianov, CINVESTAV-IPN Guadalajara, Mexico; ITESO University, Mexico

The aim of this paper is to present a new class of recurrent neural networks, which solve linear programming. It is considered as a sliding mode control problem, where the network structure is based on the Karush-Kuhn-Tucker (KKT) optimality conditions, and the KKT multipliers are the control inputs to be implemented with fixed time stabilizing terms, instead of common used activation functions. Thus, the main feature of the proposed network is its fixed convergence time to the solution, which means, there it is a time independent to the initial conditions in which the network converges to the optimization solution. The applicability of the proposed scheme is tested on real-time optimization of an electrical microgrid prototype.

Thursday, July 10, 3:30PM-6:00PM

Poster Session: PN4 Poster Session 4

Thursday, July 10, 3:30PM-6:00PM, Room: Posters Area (Level 3), Chair: Pablo Estevez

P701 *Compressive Direction-of-Arrival Estimation via Regularized Multiple Measurement FOCUSS Algorithm [#N-14938]*

Shuyuan Yang, Min Wang and Bin Li, Xidian University, China; Xidian University, China

The recently developed Compressed Sensing (CS) theory has made the super-resolution of spectrum estimation possible. In this paper, we exploit the joint sparsity of received signals to develop a new Compressive Direction-of-Arrival Estimation approach via a new Regularized Multiple Measurment FOCal Underdetermined System Solver (RMM-FOCUSS) Algorithm. It can overcome the resolution limitation of traditional spatial energy spectrum estimation algorithm, such as MUSIC algorithm, and present more accurate estimation of direction of multiple sources when there are a few number of antenna units. Some experiments are taken to validate the performance of our proposed method.

P702 *Effective Identification of a Turbogenerator in a SMIB Power System Using Fuzzy Neural Networks [#N-14376]*

Wissam A. Albukhanajer, Hussein A. Lefta and Abduladhem A. Ali, University of Surrey, United Kingdom; Foundation of Technical Education, Iraq; University of Basrah, Iraq

This paper presents modelling and identification of a turbogenerator in a single-machine-infinite-bus (SMIB) power grid utilizing Fuzzy Neural Networks (FuNNs) to construct an online adaptive identifier for the turbogenerator. It is well known that a turbogenerator is a highly nonlinear, fast acting and multivariable system usually connected to a power system. When major power system disturbances occur, protection and control actions are required to stop power system instability and restore the system to a normal state by minimizing the impact of the disturbance. Therefore, effective intelligent techniques are required to model and identify such a complex power system. In this paper, a FuNN identifier (FuNNI) of a turbogenerator model is proposed. Computer simulations are carried out to investigate the modelling after deriving the mathematical model of the turbogenerator equipped with a conventional turbine governor and automatic voltage regulator (AVR). Inverse identification scheme is adopted using a multi-input multi-output (MIMO) fuzzy neural network. Empirical results show that the proposed FuNNI is capable of successfully identifying a highly nonlinear turbogenerator system and robust even when the configurations of the plant change due to faults in the power system.

P703 *Multi-Agent Systems Applied to Topological Reconfiguration of Smart Power Distribution Systems [#N-14664]*

Filipe Saraiva and Eduardo Asada, University of Sao Paulo, Brazil

One of the various features expected for a smart power distribution system - a smart grid in the power distribution level - is the possibility of the fully automated operation for certain control actions. Although this is very expected, it requires various logic, sensor and actuator technologies in a system which, historically, has a low level of automation. One of the most analyzed problems for the distribution system is the topology reconfiguration. The reconfiguration has been applied to various objectives: minimization of power losses, voltage regulation, load balancing, to name a few. The solution method in most cases is centralized and its application is not in real-time. From the new perspectives of advanced distribution systems, fast and adaptive response of the control actions are required, specially in the presence of alternative generation sources and electrical vehicles. In this context, the multi-agent system, which embeds the necessary control actions and decision making is proposed for the topology reconfiguration aiming the loss reduction. The concept of multi-agent system for distribution system is proposed and two case studies with 11-Bus and 16-Bus system are presented.

P704 *Heuristically Enhanced Dynamic Neural Networks for Structurally Improving Photovoltaic Power Forecasting [#N-14720]*

Naji Al-Messabi, Cindy Goh, Ibrahim El-Amin and Yun Li, University of Glasgow, United Kingdom; King Fahd University of Petroleum and Minerals, Saudi Arabia

Among renewable generators, photovoltaics (PV) is showing an increasing suitability and a lowering cost. However, integration of renewable energy sources possesses many challenges, as the intermittency of these non-conventional sources often requires generation forecast, planning and optimal management. There exists scope to improve present PV yield forecasting models and methods. For example, the popular dynamic neural network modelling method suffers from the lack of a selection mechanism for an optimal network structure. This paper develops an enhanced network for short-term forecasting of PV power yield, termed a 'focused time-delay neural network' (FTDNN). The problem of optimizing the FTDNN structure is reduced to optimizing the number of delay steps and the number of neurons in the hidden layer alone and this problem is conveniently solved through heuristics. Two such algorithms, a genetic algorithm and particle swarm optimization (PSO) have been tested and both prove efficient and can

improve the forecasting accuracy of the dynamic network. Given the success of the PSO in solving this discontinuous structural optimization problem, it is expected that PSO offers potential in optimizing both the structure and parameters of a forecasting model.

P705 *Data Mining Paradigm Based on Functional Networks with Applications in Landslide Prediction [#N-14011]*

Ailong Wu, Zhigang Zeng and Chaojin Fu, Xi An Jiao Tong University, China; Huazhong University of Science and Technology, China; Hubei Normal University, China

In this paper, a new intelligence paradigm scheme to forecast landslide based on functional networks is presented. Both methodology and learning algorithm for this kind of intelligence system paradigm using the minimax method are derived. The performance and validity of the new functional networks intelligence paradigm are demonstrated by using real-world example. The results show that the landslide prediction using functional networks is reasonable, effective and achieves a high-quality performance.

P706 *The State of the Art of Memristive Neural Systems: Models and Applications [#N-14033]*

Ailong Wu, Zhigang Zeng and Chaojin Fu, Xi An Jiao Tong University, China; Huazhong University of Science and Technology, China; Hubei Normal University, China

Memristive neural systems are a groundbreaking concept that is helping to understand the behavior of many physical, technical and bionic systems. This paper reviews the research status of memristive neural systems in the past few years. Considering there are too many publications about the memristive neural systems, we summarize the relevant models and applications rather than contemplating to go into details of particular results. First, some representative models of memristive neural systems are simply introduced. Then, we briefly describe some novel applications in the related fields (dynamic information storage or retrieval, logical operations and ultra-high-performance computing). Subsequently, some existing problems are summarized, and finally, the trend of memristive neural systems is pointed out.

P707 *Integrating Local and Global Manifold Structures for Unsupervised Dimensionality Reduction [#N-14039]*

Xiaochen Chen, Jia Wei, Jinhai Li and Xiaodong Zhang, South China University of Technology, China; Sun Yat-sen University, China

Recently there has been a lot of interest in geometrically motivated approaches dealing with data in high dimensional spaces. We consider the case where data is sampled from a low dimensional manifold which is embedded in high dimensional Euclidean space. In this paper, we propose a novel unsupervised linear subspace learning algorithm called Local and Global Manifold Preserving Embedding (LGMPE). Different from existing manifold learning based linear subspace learning algorithms which aims at preserving either single kind of local manifold structure or single kind of global manifold structure on the data manifold, LGMPE can preserve different local and global manifold structures simultaneously in the graph embedding framework. Several experiments on real face datasets demonstrate the effectiveness of the proposed algorithm.

P708 *Moving Towards Accurate Monitoring and Prediction of Gold Mine Underground Dam Levels [#N-14040]*

Ali Hasan and Bhekisipho Twala, University of Johannesburg, South Africa

In this paper a comparison between an ensembles (multi-classifier) constructed of several machine learning methods (support vector machine, artificial neural network, naive Bayesian classifier, decision trees, radial basis function and k nearest neighbors) versus each single classifiers of these methods in term of gold mine underground dam levels prediction is presented. The ensembles as well as the single classifiers are used to classify, thus monitoring and predicting the underground water dam levels on a single-pump station deep gold in South Africa. In order to improve the classification accuracy an ensemble was constructed based on each single classifier performance, therefore, five ensembles were built and tested. In terms of misclassification error, the results show the ensemble to be more efficient for classification of underground water dam levels compared to each of the single classifiers.

P709 *Convolutional Deep Belief Networks for Feature Extraction of EEG Signal [#N-14041]*

Yuanfang Ren and Yan Wu, Tongji University, China

In recent years, deep learning approaches have been successfully used to learn hierarchical representations of image data, audio data etc. However, to our knowledge, these deep learning approaches have not been extensively studied for electroencephalographic (EEG) data. Considering the properties of EEG data, high-dimensional and multichannel, we apply convolutional deep belief networks to the feature learning of EEG data and evaluated it on the datasets from previous BCI competitions. Compared with other state-of-the-art feature extraction methods, the learned features using convolutional deep belief network have better performance.

P710 *Newton's Method Backpropagation for Complex-Valued Holomorphic Multilayer Perceptrons [#N-14042]*

Diana La Corte and Yi Ming Zou, University of Wisconsin-Milwaukee, United States

The study of Newton's method in complex-valued neural networks faces many difficulties. In this paper, we derive Newton's method backpropagation algorithms for complex-valued holomorphic multilayer perceptrons, and investigate the convergence of the one-step Newton steplength algorithm for the minimization of real-valued complex functions via Newton's method. To provide experimental support for the use of holomorphic activation functions, we perform a comparison of using sigmoidal functions versus their Taylor polynomial approximations as activation functions by using the algorithms developed in this paper and the known gradient descent backpropagation algorithm. Our experiments indicate that the Newton's method based algorithms, combined with the use of polynomial activation functions, provide significant improvement in the number of training iterations required over the existing algorithms.

P711 *Fuzzy c-Means Clustering with a New Regularization Term for Image Segmentation [#N-14048]*

Guangpu Shao, Huazhong University of Science and Technology, China

We present a new fuzzy c-means algorithm for image segmentation by introducing a novel spatially constrained Student's t-distribution and a new regularization term. First, considering that conventional distribution models lack spatial information and the multivariate Student's t-distribution is heavily tailed, we propose a new way to incorporate spatial information between neighboring pixels into the Student's t-distribution based on Markov random field(MRF) in order to enhance the robustness. Second, the new regularization term, inspired from geodesic active contour(GAC) with a strong ability in capturing boundary, can preserve the details of edges and further enhance its robustness to noise and outliers by capitalizing on the local context information and edge information. At last, in comparison to other Markov random fields that are complex and computationally expensive, the parameters are easily optimized with EM algorithm in our proposed method. The proposed algorithm demonstrates the robustness and effectiveness, compared with other latest methods on the synthetic and real images.

P712 *Direct Adaptive Neural Network Control of a Class of Nonlinear Systems [#N-14049]*

Baobin Miao and Tieshan Li, Dalian Maritime University, China

This paper focuses on adaptive neural network control for a class of uncertain single-input single-out nonlinear strict-feedback systems. Neural network (NN) is directly used to approximate the unknown desired control signals and a novel direct adaptive neural network controller is proposed via backstepping and the minimal learning parameter (MLP) techniques. The main advantages of the proposed controller are that: (1) the problem of "explosion of complexity" inherent in the conventional backstepping method is avoided; (2) the problem of "dimensionality curse" is solved and only one adaptive parameter that needs to be updated online. These advantages result in a much simpler adaptive control algorithm, which is convenient to implement in applications. The proposed controller guarantees that all the close-loop signals are uniform ultimate boundedness (UUB) and that the tracking errors converge to a small neighborhood of the desired trajectory. Finally, simulation studies are given to show the effectiveness of the proposed approach.

P713 *Hybrid SVM/HMM Architectures for Statistical Model-Based Voice Activity Detection [#N-14070]*

YingWei Tan, WenJu Liu, Wei Jiang and Hao Zheng, National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of Sciences, China

The decision function of support vector machine (SVM) using the likelihood ratios (LRs) is successfully used for statistical model-based voice activity detection (VAD). It is known to incorporate an optimised nonlinear decision over two different classes, instead of comparing the geometric mean of the LRs for the individual frequency bands with a given threshold for speech detection. However, the inter-frame correlation of the voice activity is not taken into consideration. In this paper, we explore a hybrid SVM/hidden Markov model (HMM) approach for the VAD, which retains discriminative and nonlinear properties of SVM, while modeling the inter-frame correlation powerfully through a first-order HMM. Experimental results show the significant improvement of the performance of the proposed VAD in comparison with the SVM-based VAD.

P714 *Novel Stability Criteria of T-S Fuzzy Hopfield Neural Networks with Time-Varying Delays and Uncertainties [#N-14081]*

Caigen Zhou, Xiaoqin Zeng and Jianjiang Yu, Hohai University,Yancheng Teachers University, China; Hohai University, China; Yancheng Teachers University, China

The problem of asymptotic stability for Takagi-Sugeno(T-S) fuzzy Hopfield neural networks with time-varying delays is studied in this paper. Based on the Lyapunov functional method, new delay-dependent stability criteria are derived in terms of Linear Matrix Inequalities (LMIs) that can be calculated easily by the LMI Toolbox in MATLAB. The proposed approach does not involve free weighting matrices and can provide less conservative results than some existing ones. Besides, numberical examples are given to show the effectiveness of the proposed approach.

P715 *A Collaborative Filtering Framework Based on Local and Global Similarities with Similarity Tie-Breaking Criteria [#N-14096]*

Andre Lopes, Ricardo Prudencio and Byron Bezerra, Federal University of Pernambuco, Brazil; University of Pernambuco, Brazil

Collaborative Filtering is the most commonly used technique in Recommender Systems, based on the users' ratings in order to identify similar profiles and suggest them items. However, because it depends essentially on direct similarity measures between users or items, it usually suffers from the sparsity problem. Upon this situation, a good alternative is using global similarities to enrich the users' neighborhood by transitively connecting them together, even when they do not share any common ratings. In this paper, we investigated the use of both local and global similarity measures with the maximin distance algorithm, along with tie-breaking criteria for neighbors with equal similarity. Our experiments showed that the maximin distance algorithm in fact produces many equally similar global neighbors, and that the criteria set for deciding between them severely improved the results of the recommendation process.

P716 *SVM Classification for Imbalanced Data Sets Using Conformal Kernel Transformations [#N-14098]*

Yong Zhang, Panpan Fu and Wenzhe Liu, Liaoning Normal University, China

The problem of classifying imbalanced datasets has drawn a significant amount of interest from academia and industry. In this paper, we propose a modified support vector machine (SVM) approach using conformal kernel transformation to address the class imbalance problem. The proposed method first uses standard SVM algorithm to obtain an approximate hyperplane. And then, we give a kernel function and compute its parameters using the chi-square test. Finally, an experimental analysis is carried out with a wide range of highly imbalanced datasets over the proposal and several other methods. The results show that our proposal outperforms previously proposed methods.

P717 *Analysis of Disease Association and Susceptibility for SNP Data Using Emotional Neural Networks [#N-14103]*

Xiao Wang, Qinke Peng and Tao Zhong, Xi'an Jiaotong Unviersity, China

The risk of some complex diseases are likely related to single nucleotide polymorphisms (SNPs), which are the most common form of DNA variations. Rapidly developing bioinformatics have made it possible to recognize a group of SNPs as the risk/protective factors of a specific disease, which are related to the possibility of the sample be infected. However, a particular algorithm to consider this kind of tendency information together is still in need. In this paper, inspired form the process that human beings to make a decision, we regard the risk/protect factor in the gene variations as the emotional of our nervous system. In this way, we regard these SNP combination factor as prior knowledge and use the emotional neural networks (ENN) to analysis the disease susceptibility. By sending this kind of information to ENN and using particle swarm optimization with hierarchical structure (PSO_HS) to train the parameters, we get a better result of susceptibility classification. The experimental results about real dataset shows that consider the risk/protect factor by emotional neural networks improve the performance of disease susceptibility analysis.

P718 *Artificial Immune System Application for Solving Dynamic Optimization Problems [#N-14109]*

Zhijie Li, Yuanxiang Li, Kuang Li and Fei Yu, State Key Laboratory of Software Engineering, Wuhan University, China

For the purpose of adaptation to a changing environment, immune mutation and memory mechanism in the immune system are introduced in thermodynamic genetic algorithm, which helps to prevent the diversity loss and rapidly track the optimum in dynamic environments. Experimental results on 0/1 dynamic knapsack problems demonstrate the merits of the proposed immune thermodynamic genetic algorithm (ITDGA). Compared with the existing classical primal-dual genetic algorithm(PDGA), this algorithm can maintain better diversity and be more suitable to solve 0-1 dynamic problems.

P719 *Synchronization Control of Hybrid-Coupled Heterogeneous Complex Networks [#N-14115]*

Jianqiang Hu, Jinling Liang and Jinde Cao, Southeast University, China

This paper is concerned with the problem of synchronization control for the delayed hybrid-coupled heterogeneous network with stochastic disturbances.

To begin with, the open-loop control is imposed on the whole network, based on which the pinning adaptive control and the impulsive control are introduced to synchronize the whole network to an arbitrary objective trajectory. Furthermore, by employing stochastic analysis techniques and the improved Halanay inequality, some easy-to-verify sufficient conditions are derived to guarantee the asymptotic/exponential synchronization in the mean square of the complex network under study. Numerical example of a directed network is illustrated to demonstrate the applicability and efficiency of the proposed theoretical results.

P720 *Robust LS-SVR Based on Variational Bayesian and Its Applications [#N-14118]*

Kefeng Ning, Min Liu, Mingyu Dong and Zhansong Wu, Tsinghua University, China

Outliers often exist in the data for modeling in actual industrial processes. If these outliers are used as support vectors, the obtained Support Vector Regression function maybe unreliable. In this paper, we propose a new Robust Least Squares Support Vector Regression based on variational Bayesian (RB-LSSVR). The main idea of RB-LSSVR is to learn the parameters of LSSVR in Bayesian framework, but replace the Gaussian distribution with Student's t-distribution as the probability density function of residuals of the model output and real output, which makes the model more robust to outliers. In order to solve RB-LSSVR, the Student's t-distribution is written as a scale-mixture form and variational approximation is used to iteratively learn the parameters of RB-LSSVR. The hyperparameters of the Gamma distribution that can't be solved explicitly are optimized by using Newton method. And, by using variational Bayesian, the user-specified parameters selection is simplified in RB-LSSVR. The numerical results based on several benchmark regression problems and one actual industrial modeling problem show the proposed RB-LSSVR can handle outliers very well.

P721 *Label Propagation and Soft-Similarity Measure for Graph Based Constrained Semi-Supervised Learning [#N-14130]*

Zhao Zhang, Mingbo Zhao and Tommy W.S. Chow, Soochow University, China; City University of Hong Kong, Hong Kong

This paper discusses a new setting of graph based semi-supervised learning (SSL) guided using pairwise constraints (PCs). Technically, we propose a novel Graph based Constrained Semi-Supervised Learning (G-CSSL) framework. In this setting, PCs are used to specify the types (intra- or inter-class) of points with labels. Because the number of labeled data is typically small in SSL setting, the core idea of this framework is to create and enrich the PCs sets using the propagated soft labels from both labeled and unlabeled data via special label propagation (SLP), and hence obtaining more supervised information for delivering enhanced learning performance. To obtain the predicted labels of unlabeled data, we calculate the sparse codes of all data vectors jointly to assign weights for SLP. To deliver enhanced inter-class separation and intra-class compactness, we also present a mixed soft-similarity measure to evaluate the similarity/dissimilarity of constrained sample pairs by using the sparse codes and outputted probabilistic values by SLP. Extensive simulations demonstrated the effectiveness of our G-CSSL for image representation and recognition, compared with other related SSL techniques.

P722 *An Improved RBM Based on Bayesian Regularization [#N-14151]*

Guangyuan Pan and Junfei Qiao, Beijing University of Technology, China

Restricted Boltzmann Machine is a fundamental method in deep learning networks. Training and generalization is an ill-defined problem in that many different networks may achieve the training goal; however each will respond differently to an unknown input. Traditional approaches include stopping the training early and/or restricting the size of the network. These approaches ameliorate the problem of over-fitting where the network learns the patterns presented but is unable to generalize. Bayesian regularization addresses these issues by requiring the weights of the network to attain a minimum magnitude. This ensures that non-contributing weights are reduced significantly and the resulting network represents the essence of the inter-relations of the training. Bayesian Regularization simply introduces an additional term to the objective function. This term comprises the sum of the squares of the weights. The optimization process therefore not only achieves the objective of the original cost (i.e. the minimization of an error metric) but it also ensures that this objective is achieved with minimum-magnitude weights. We have introduced Bayesian Regularization in the training of Restricted Boltzmann Machines and have applied this method in experiments of hand-written numbers classification. Our experiments showed that by adding Bayesian regularization in the training of RBMs, we were able to improve the generalization capabilities of the trained network by reducing its recognition errors by more than 1.6%.

P723 *On the Cooperative Observability of a Continuous-Time Linear System on an Undirected Network [#N-14158]*

Henghui Zhu, Kexin Liu, Jinhu Lu, Zongli Lin and Yao Chen, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, China; University of Virginia, United States; Beijing Jiaotong University, China

In traditional control theory, a single observer has access all the measured outputs of the plant to estimates its asymptotically. In many real world engineering systems, it may be difficult to build a single observer that has access to all the measured outputs. One way around this difficulty is to build a network of cooperative observers, each of which obtains a portion of the measurement outputs, that collectively produce an asymptotic estimate of the plant state. In this paper, we construct a network of such observers for a continuous-time linear system. Assuming that these observers are connected through an undirected connected network, we establish a necessary and sufficient condition on the plant parameters under which the network of observers will achieve asymptotic omniscience. A network of cooperative observers is said to achieve asymptotic omniscience if their states all converge to the plant state asymptotically. Numerical simulation results are presented to validate theoretical results. The design of cooperative observers sheds some light on the solution of some other real-world problems, such as the design of networked location-based services and sensor networks.

P724 *Robust Bilinear Matrix Recovery by Tensor Low-Rank Representation [#N-14162]*

Zhao Zhang and Mingbo Zhao, Soochow University, China; City University of Hong Kong, Hong Kong

For low-rank recovery and error correction, Low-Rank Representation (LRR) row- reconstructs given data matrix X by seeking a low-rank representation, while Inductive Robust Principal Component Analysis (IRPCA) aims to calculate a low- rank projection to column-reconstruct X. But either column or row information of X is lost by LRR and IRPCA. In addition, the matrix X itself is chosen as the dictionary by LRR, but (grossly) corrupted entries may greatly depress its performance. To solve these issues, we propose a simultaneous low-rank representation and dictionary learning framework termed Tensor LRR (TLRR) for robust bilinear recovery. TLRR reconstructs given matrix X along both row and column directions by computing a pair of low-rank matrices alternately from a nuclear norm minimization problem for constructing a low-rank tensor subspace. As a result, TLRR in the optimizations can be regarded as enhanced IRPCA with noises removed by low-rank representation, and can also be considered as enhanced LRR with a clean informative dictionary using a low-rank projection. The comparison with other criteria shows that TLRR exhibits certain advantages, for instance strong generalization power and robustness enhancement to the missing values. Simulations verified the validity of TLRR for recovery.

P725 *Using Chou's Amphiphilic Pseudo-Amino Acid Composition and Extreme Learning Machine for Prediction of Protein-Protein Interactions [#N-14175]*

Qiao-Ying Huang, Zhu-Hong You, Shuai Li and Zexuan Zhu, Harbin Institute of Technology Shenzhen Graduate School, China; Shenzhen University, China; The Hong Kong Polytechnic University, Hong Kong

Protein-protein interactions (PPIs) play crucial roles in the execution of various cellular processes. Almost every cellu- lar process relies on transient or permanent physical bindings of proteins. Unfortunately, the experimental methods for identifying PPIs are both time-consuming and expensive. Therefore, it is important to develop computational approaches for predicting PPIs. In this study, a novel approach is presented to predict PPIs using only the information of protein sequences. This method is developed based on learning algorithm-Extreme Learning Machine (ELM) combined with the concept of Chous Pseudo- Amino Acid Composition (PseAAC) composition. PseAAC is a combination of a set of discrete sequence correlation factors and the 20 components of the conventional amino acid composition, so this method can observe a remarkable improvement in prediction quality. ELM classifier is selected as prediction engine, which is a kind of accurate and fast-learning innovative classification method based on the random generation of the input-to-hidden- units weights followed by the resolution of the linear equations to obtain the hidden-to-output weights. When performed on the PPIs data of Saccharomyces cerevisiae, the proposed method achieved 79.66% prediction accuracy with 79.16% sensitivity at the precision of 79.96%. Extensive experiments are performed to compare our method with state-of-the-art techniques Support Vector Machine (SVM). Achieved results show that the proposed approach is very promising for predicting PPIs, and it can be a helpful supplement for PPIs prediction.

P726 *Joint Multiple Dictionary Learning for Tensor Sparse Coding [#N-14205]*

Yifan Fu, Junbin Gao, Yanfeng Sun and Xia Hong, Charles Sturt University, Australia; Beijing University of Technology, China; University of Reading, United Kingdom

Traditional dictionary learning algorithms are used for finding a sparse representation on high dimensional data by transforming samples into a one-dimensional (1D) vector. This 1D model loses the inherent spatial structure property of data. An alternative solution is to employ Tensor Decomposition for dictionary learning on their original structural form --a tensor-- by learning multiple dictionaries along each mode and the corresponding sparse representation in respect to the Kronecker product of these dictionaries. To learn tensor dictionaries along each mode, all the existing methods update each dictionary iteratively in an alternating manner. Because atoms from each mode dictionary jointly make contributions to the sparsity of tensor, existing works ignore atoms correlations between different mode dictionaries by treating each mode dictionary independently. In this paper, we propose a joint multiple dictionary learning method for tensor sparse coding, which explores atom correlations for sparse representation and updates multiple atoms from each mode dictionary simultaneously. In this algorithm, the Frequent-Pattern Tree (FP-tree) mining algorithm is employed to exploit frequent atom patterns in the sparse representation. Inspired by the idea of K-SVD, we develop a new dictionary update method that jointly updates elements in each pattern. Experimental results demonstrate our method outperforms other tensor based dictionary learning algorithms.

P727 *Dependent Stotchastic Blockmodels [#N-14587]*

Eunsil Gim, Juho Lee and Seungjin Choi, Samsung, Korea, Republic of; Pohang University of Science and Technology, Korea, Republic of

A stochastic blockmodel is a generative model for blocks, where a block is a set of coherent nodes and relations between the nodes are explained by the corresponding pair of blocks. Most existing methods make use of both the presence and the absence of links between nodes, encoded by the adjacency matrix, to learn the corresponding models. In this paper, we present a new method in which we use only the presence of links to learn the model, exploiting the dependency between source and destination nodes, leading to a dependent stochastic blockmodel. We allow for mixed membership and the degrees of nodes in our dependent stochastic blockmodel. Experiments on the political books network and Twitter social network indicate that the behavior of our dependent stochastic blockmodel is superior to that of existing methods.

P728 *Splitted Neural Networks for Better Performance of Antenna Optimization [#N-14590]*

Linh Ho Manh, Francesco Grimaccia, Marco Mussetta and Riccardo E. Zich, Politecnico di Milano, Italy

In recent years, evolutionary algorithms have been successfully adopted for the optimization of various electromagnetic problems. One of the most common electromagnetic application is in the framework of microstrip antennas, thanks to the advantage of being low cost and low profile. In order to reduce the computational effort of the electromagnetic optimization, a suitable equivalent model by ANN has been created in order to substitute the commercially available full-wave analysis solvers. With the aim of reducing committed error level, a new solution of multiple neural networks instead of one network is presented. In addition, efficiency of new training scheme is also shown in Numerical results section. The effectiveness of proposed techniques will be illustrated by optimizing a particular type of antenna, namely proximity coupled feed.

P729 *Learning Features with Structure-Adapting Multi-View Exponential Family Harmoniums [#N-14607]*

Kang Yoonseop and Choi Seungjin, Pohang University of Science and Technology, Korea (South)

Existing multi-view feature extraction methods are based on restrictive assumptions on the connections between feature vectors and input data. These assumptions damage the quality of learned features, and also require more effort on choosing right dimensions of feature vector components connected to each view. In this paper we present adaptive multi-view harmonium (SA-MVH) for multi-view feature extraction, where its each hidden node chooses the views to connect with while training phase via switch parameters. "Switch" parameters are multiplied to the connection weights of ordinary exponential family harmoniums (EFH) to decide the existence of connection between hidden nodes and views. With switch parameters, a SA-MVH automatically adapts its structure to achieve better representation of data distribution. The model can also be easily trained using the same training algorithms used for EFHs. Numerical experiments on synthetic and real-world datasets demonstrate the useful behavior of the SA-MVH, compared to the existing multi-view feature extraction methods.

P730 *Outdoor Scene Understanding Using SEVI-BOVW Model [#N-14644]*

Haibing Zhang, Shirong Liu and Chaoliang Zhong, Hangzhou Dianzi University, China; East China University of Science and Technology, China

A simple and effective novel approach for scene understanding is addressed in this paper. Based on bag of visual words (BOVW) model, explicit semantics associated with the object image was embedded into visual words, and then various types of visual words integrated, and finally the SEVI-BOVW (semantics embedded and vocabulary integrated bag of visual words) model constructed. Mean Shift algorithm was employed to recognize local region image in scene. Compared with image understanding approaches presented in the literature, the proposed approach here can remove a classification or generative model during model training or testing. Objects' category recognition can be determined by the number of class-specific semantic visual words, without complex reasoning. The effectiveness of the proposed approach has been demonstrated by the experimental results of scene understanding in a campus.

P731 *Global Exponential Stability of Delayed Hopfield Neural Network on Time Scale [#N-14648]*

Xuehui Mei and Haijun Jiang, Xinjiang University, China

In This paper, by using the theory of calculus on time scales and constructing some suitable Liapunov functions, we obtained the existence, uniqueness and global exponential stability of equilibrium point of delayed Hopfield neural network with impulses on time scale.The conditions can be easily checked in practice by simple algebraic methods.

P732 *Application of Neural Networks to Evaluate Experimental Data of Galvanic Zincing [#N-14680]*

Peter Michal, Jan Pitel, Alena Vagaska and Ivo Bukovsky, Technical University of Kosice, Slovakia; Czech Technical University in Prague, Czech Republic

In order to improve corrosion resistance of alloy S355 EN 1025, the relationship between the thickness of zinc coating created during the process of acidic galvanic zincing and factors that influence this process were investigated. Influence of individual factors on thickness of zinc coating for sample area with surface current density of 3 Adm-2 was determined by planned experiment which uses central composite plan. The obtained experimental data were evaluated based on neural network theory using cubic neural unit with Levenberg-Marquardt iterative adaptive algorithm. The influence of number of training data on the reliability of the obtained computational model has been studied. Furthermore, relationship between the amount of training data and reliability of prediction for the thickness of created zinc layer was observed. The relationship between input factors and thickness of layer coating with 88.37% reliability was reached.

P733 *Iris Liveness Detection Methods in the Mobile Biometrics Scenario [#N-14705]*

Ana F. Sequeira, Juliano Murari and Jaime S. Cardoso, Universidade do Porto, Portugal; Universidade Federal de S. Paulo, Brazil

Biometric systems based on iris are vulnerable to direct attacks consisting on the presentation of a fake iris to the sensor (a printed or a contact lenses iris image, among others). The mobile biometrics scenario stresses the importance of assessing the security issues. The application of countermeasures against this type of attacking scheme is the problem addressed in the present paper. Widening a previous work, several state-of-the-art iris liveness detection methods were implemented and adapted to a less-constrained scenario. The proposed method combines a feature selection step prior to the use of state-of-the-art classifiers to perform the classification based upon the ``best features''. Five well known existing databases for iris liveness purposes (Biosec, Clarkson, NotreDame and Warsaw) and a recently published database, MobBIOfake, with real and fake images captured in the mobile scenario were tested. The results obtained suggest that the automated segmentation step does not degrade significantly the results.

P734 *Nonnegative Shifted Tensor Factorization in Time Frequency Domain [#N-14783]*

Qiang Wu, Ju Liu, Fengrong Sun, Jie Li and Andrzej Cichocki, Shandong University, China; Tongji University, China; BSI RIKEN, Japan

In this paper, we proposed a Nonnegative Shifted Tensor Factorization (NSTF) model considering multiple component delays by time frequency analysis. Explicit mathematical representation for the delays is presented to recover the patterns from the original data. In order to explore multilinear shifted component in different modes, we use fast fourier transform (FFT) to transform the non-integer delays into frequency domain by gradients search. The ALS algorithm for NSTF is developed by alternating least square procedure to estimate the nonnegative factor matrices in each mode and enforce the sparsity of model. Simulation results indicate that ALS-NSTF algorithm can extract the shift-invariance sparse features and improve the recognition performance of robust speaker identification and structural magnetic resonance imaging (sMRI) diagnosis for Alzheimer's Disease.

P735 *Modeling of Vertical Mill Raw Meal Grinding Process and Optimal Setting of Operating Parameters Based on Wavelet Neural Network [#N-14784]*

Xiaofeng Lin and Zhe Qian, Guangxi University, China

The stability of vertical mill raw meal grinding process affect the yield and quality of cement clinker. Due to the nonlinear of grinding process, random variation of working conditions, and large lag of the offline index test, it is difficult to establish an accurate mathematics model, thus cannot collect the optimizing operating parameters of vertical mill in time. In this paper, based on the principal component analysis (PCA) for the related variables, a production index prediction model of vertical mill raw meal grinding process was established using wavelet neural network (WNN) and compared with the BP network model, and the validity of the novel model was verified. Then, based on the prediction model and related constraint conditions, the parametric optimization model was established, wherein, the optimal operating setting value under typical working conditions was obtained by using particle swarm optimization algorithm, and an optimal case base was established; through the case inquiry and revision, the optimal set points under the current conditions was obtained. The simulation results showed that, the novel wavelet neural network model and the parameter optimizing setting method could adapt to the changing of process indicators, and could provide optimal parameter value to make the production performance meet expectations, meanwhile achieved the optimizing goal.

P736 *Kernel Robust Mixed-Norm Adaptive Filtering [#N-14803]*

Jin Liu, Hua Qu, Badong Chen and Wentao Ma, XI'AN JIAOTONG UNIVERSITY, China; Xi'an Jiaotong University, China

Kernel methods are powerful for developing a nonlinear learning algorithm in a high-dimensional linear space. The least mean square (LMS) and the least absolute deviation (LAD) are two well-known linear adaptive filtering algorithms. The former performs very well when the noise is Gaussian, while the later possesses desirable performance when the noise has a long-tailed distribution (e.g. alpha-stable distribution). The combination of the LMS and LAD yields a robust mixed-norm (RMN) algorithm. In this paper, we combine the popular kernel methods and the RMN algorithm to develop a new kernel adaptive filtering algorithm, namely the kernel RMN (KRMN) algorithm, which is a robust adaptive algorithm in reproducing kernel Hilbert space (RKHS). The mean square convergence is analyzed, and the excellent and robust performance of the new algorithm is demonstrated by the simulation results of nonlinear time series prediction.

P737 *Soft-Constrained Nonnegative Matrix Factorization via Normalization [#N-14842]*

Long Lan, Naiyang Guan, Xiang Zhang, Dacheng Tao and Zhigang Luo, National University of Defense Technology, China; University of Technology, Sydney, Australia

Semi-supervised clustering aims at boosting the clustering performance on unlabeled samples by using labels from a few labeled samples. Constrained NMF (CNMF) is one of the most significant semi-supervised clustering methods, and it factorizes the whole dataset by NMF and constrains those labeled samples from the same class to have identical encodings. In this paper, we propose a novel soft-constrained NMF (SCNMF) method by softening the hard constraint in CNMF. Particularly, SCNMF factorizes the whole dataset into two lower- dimensional factor matrices by using multiplicative update rule (MUR). To utilize the labels of labeled samples, SCNMF iteratively normalizes both factor matrices after updating them with MURs to make encodings of labeled samples close to their label vectors. It is therefore reasonable to believe that encodings of unlabeled samples are also close to their corresponding label vectors. Such strategy significantly boosts the clustering performance even when the labeled samples are rather limited, e.g., each class owns only a single labeled sample. Since the normalization

procedure never increases the computational complexity of MUR, SCNMF is quite efficient and effective in practices. Experimental results on face image datasets illustrate both efficiency and effectiveness of SCNMF compared with both NMF and CNMF

P738 *Latency-Based Probabilistic Information Processing in a Learning Feedback Hierarchy [#N-14849]*

Alexander Gepperth, ENSTA ParisTech, Palaiseau, France

In this article, we study a three-layer neural hierarchy composed of bi-directionally connected recurrent layers which is trained to perform a synthetic object recognition task. The main feature of this network is its ability to represent, transmit and fuse probabilistic information, and thus to take near-optimal decisions when inputs are contradictory, noisy or missing. This is achieved by a neural space-latency code which is a natural consequence of the simple recurrent dynamics in each layer. Furthermore, the network possesses a feedback mechanism that is compatible with the space-latency code by making use of the attractor properties of neural layers. We show that this feedback mechanism can resolve/correct ambiguities at lower levels. As the fusion of feedback information in each layer is achieved in a probabilistically coherent fashion, feedback only has an effect if low-level inputs are ambiguous.

P739 *Improving the Genetic-Algorithm-Optimized Wavelet Neural Network for Stock Market Prediction [#N-14941]*

Yu Fang, Kamaladdin Fataliyev, Lipo Wang, Xiuju Fu and Yaoli Wang, Nanyang Technological University, Singapore; Institute of high performance computing, Singapore; Taiyuan University of Technology, China

This paper improves stock market prediction based on genetic algorithms (GA) and wavelet neural networks (WNN) and reports significantly better accuracies compared to existing approaches to stock market prediction, including the hierarchical GA (HGA) WNN. Specifically, we added information such as trading volume as inputs and we used the Morlet wavelet function instead of Morlet-Gaussian wavelet function in our prediction model. We also employed a smaller number of hidden nodes in WNN compared to other research work. The prediction system is tested using Shenzhen Composite Index data.

P740 *Optimal Software Maintenance Policy Based on Reliability and Risk [#N-14950]*

Xiaoping Wang, Fang Zhou and Yi Shen, Huazhong University of Science and Technology, China

Software maintenance is assuming ever more a crucial role in the lifecycle of software due to the increase of software requirements and the high variability of software environment. Common approaches of studying software maintenance are to consider them as a static by-product of software operation and only the maintenance cost is covered. In this paper, software maintenance policies are studied with the consideration of software reliability and risk. An optimization model is defined to drive the choice of a maintenance schedule. The solution of the model provides the best maintenance policy and the choice of actual actions that will minimize the average maintenance cost while the software reliability and risk are acceptable. Finally, a numerical example is given to show the analysis process of our proposed policy.

P741 *Forecasting Electricity Consumption in South Africa: ARMA, Neural Networks and Neuro-Fuzzy Systems [#N-14816]*

Lufuno Marwala and Twala Bhekisipho, University of Johannesburg, South Africa

This paper presents an experiment that consists of constructing auto-regressive moving average (ARMA), neural networks and neuro-fuzzy models with historical electricity consumption time series data to create models that can be used to forecast consumption in the future. The data was sampled on a monthly basis from January 1985 to December 2011. An ARMA, multilayer perceptron neural network with back propagation and neuro-fuzzy modelling technique which combines Takagi-Sugeno fuzzy models and neural networks were used to create the models for one step ahead forecasting. The results of the three techniques were compared and the results show that neuro-fuzzy models outperformed the neural network and ARMA models in terms of accuracy.

P742 *PVis - Partitions' Visualizer: Extracting Knowledge by Visualizing a Collection of Partitions [#N-14478]*

Katti Faceli, Tiemi Sakata, Andre Carvalho and Marcilio de Souto, Universidade Federal de Sao Carlos, Brazil; Universidade de Sao Paulo, Brazil; LIFO/Univ. Orleans, France

Recent advances in cluster analysis highlight the importance of finding multiple meaningful partitions and point out to the need for approaches to evaluate them. They also suggest that the evaluation should consider knowledge of a domain expert. In this paper, we present a visualization method, called PVis (Partition's Visualizer), that allows the integrated visualization of a collection of partitions. PVis allows to compare the content of a set of partitions. The comparison can be done with respect to priori knowledge provided by an expert. PVis can be useful in the discovery of relevant information to the domain experts performing cluster analysis. In order to illustrate our approach, we give an example of how to perform an exploratory analysis of collections of partitions. In order to do so, we use a well-known dataset from the Bioinformatics domain, regarding molecular classification of cancer.

Thursday, July 10, 4:00PM-6:00PM

Special Session: ThN2-1 Applications of Neural Networks for Financial Modeling and Forecasting

Thursday, July 10, 4:00PM-6:00PM, Room: 308, Chair: Massimo Panella

4:00PM *Adaptively Weighted Support Vector Regression for Financial Time Series Prediction [#N-14107]*

Zhijie Li, Yuanxiang Li, Fei Yu and Dahai Ge, Wuhan University, China

The financial data are usually volatile and contain outliers. One problem of the standard support vector regression (SVR) for financial time series prediction is that it considers data in a fixed fashion only and lack the robustness to outliers. To tackle this issue, we propose the adaptively weighted support vector regression (AWSVR) model. This novel model is demonstrated to choose the weights adaptively with data. Therefore, the AWSVR can tolerate noise adaptively. The experimental results on three indices: the NASDAQ, the Standard and Poor 500 index, and the FSTE100 index (FSTE) show its advantages over the standard SVR.

4:20PM *A Higher-Order Fuzzy Neural Network for Modeling Financial Time Series [#N-14328]*

Massimo Panella, Luca Liparulo and Andrea Proietti, University of Rome "La Sapienza", Italy

This work investigates on the widespread use of fuzzy neural networks in time series forecasting, concerning in particular the energy commodity markets. We propose a new learning strategy suited to any neural model. The proposed approach is further assessed in the case of higher-order Sugeno-type fuzzy rules, which are able to replicate the daily data and to reproduce the same statistical features for various Commodity time series. The data used are obtained from the daily return series of specific energy commodities, such as coal, natural gas, crude oil and electricity, over the period 2001-2010 for both the European and US markets. We will prove that our approach can obtain interesting results in terms of prediction accuracy and volatility estimation, compared to well-known neural and fuzzy neural models and to the ARMA-GARCH statistical paradigm.

4:40PM *Beating The S-and-P 500 Index - A Successful Neural Network Approach [#N-14400]*

Mininder Sethi, Philip Treleaven and Sebastian Del Bano Rollin, University College London, United Kingdom

The systematic trading of equities forms the basis of the asset management industry. Analysts are trying to outperform a passive investment in an index such as the S-and-P 500 Index. However, statistics have shown that most analysts fail to consistently beat the index. A number of Neural Network based methods for detecting trading opportunities on Futures contracts on the S-and-P 500 Index have been published in the literature. However, such methods have generally been unable to demonstrate sustained performance over a significant period of time. The authors of this paper show, through the application of over ten years of experience in quantitative modeling and trading, a different type of Neural Network approach to beating the S-and-P 500 Index. Rather than trading Futures contracts, it is shown that by using Neural Networks to intelligently select just a handful of stocks a performance significantly in excess of a buy and hold position on the S-and-P 500 Index could have been achieved over a seven year period. The effect of transaction costs is also considered.

5:00PM *Stock Volatility Prediction Using Multi-Kernel Based Extreme Learning Machine [#N-14444]*

Feng Wang, Zhiyong Zhao, Xiaodong Li and Fei Yu, State Key Lab of Software Engineering, Wuhan University, China; City University of Hong Kong, Hong Kong

Stock price volatility prediction is regarded as one of the most attractive and meaningful research issues in financial market. Some existing researches have pointed out that both the prediction accuracy and the prediction speed are the most important facts in the process of stock prediction. In this paper, we focus on the problem of how to design a methodology which can improve prediction accuracy as well speed up prediction process, and propose a multi-kernel based extreme learning machine (MK-ELM) model to enhance the prediction performance. ELM is a fast learning model and has been successfully applied in many research fields. Based on ELM, this MK-ELM has the benefits of both multiple kernel learning and ELM, which can well balanced the requirements of both prediction accuracy and prediction speed. To validate the performance of the proposed MK- ELM, we take experiments on HKEx 2001 stock market datasets. The market historical price and the market news are implemented in our MK-ELM. We Compare our proposed MK-ELM with Back-Propagation Neural Network(BP-NN), Support Vector Machine(SVM), Basic ELM and K-ELM. Experimental results show that, 1) MK- ELM, K- ELM and SVM get higher prediction accuracy than BP-NN and B-ELM; 2) Both MK-ELM and K-ELM can achieve faster prediction speed than SVM and BP-NN in most cases; 3) MK-ELM has higher prediction accuracy in some cases than K-ELM and SVM.

5:20PM *Augmented Neural Networks for Modelling Consumer Indebtness [#N-14614]*

Alexandros Ladas, Jon Garibaldi, Rodrigo Scarpel and Uwe Aickelin, University of Nottingham, United Kingdom

Consumer Debt has risen to be an important problem of modern societies, generating a lot of research in order to understand the nature of consumer indebtness, which so far its modelling has been carried out by statistical models. In this work we show that Computational Intelligence can offer a more holistic approach that is more suitable for the complex relationships an indebtness dataset has and Linear Regression cannot uncover. In particular, as our results show, Neural Networks achieve the best performance in modelling consumer indebtness, especially when they manage to incorporate the significant and experimentally verified results of the Data Mining process in the model, exploiting the flexibility Neural Networks offer in designing their topology. This novel method forms an elaborate framework to model Consumer indebtness that can be extended to any other real world application.

5:40PM *A New Investment Strategy Based on Data Mining and Neural Networks [#N-14776]*

Chang Liu and Hafiz Malik, University of Michigan - Dearborn, United States

In this paper, we present a new investment strategy for optimal gains on investments in the stock market. Neural Network (NN)-based framework is used for trading prediction and forecasting. To this end, statistical measures based on return and volatility are used to filter out low performing sectors in the stock market. A simple but effective method based on price Simple Moving Averages (SMAs) is used to measure volatility for a given stock. The proposed NN-based system uses the strongest performing indices for stock market forecasting. In addition to predicting investment decisions such as Buy or Sell, the proposed framework also aims at maximizing investment gains (or returns). The proposed NN-based framework rely on historical data and provides investors investing strategies for optimal trading. Training data is extracted extracted from historical weekly data (from the Yahoo Finance). Simulation results indicate that the proposed framework can help investors making investment decisions and increasing their trading profitability.

Special Session: ThN2-2 Incremental Machine Learning: Methods and Applications

Thursday, July 10, 4:00PM-6:00PM, Room: 305A, Chair: Nicoleta Rogovschi and Nistor Grozavu

4:00PM *Locally Linear Embedding Algorithm Based on OMP for Incremental Learning [#N-14153]*

Yiqin Leng, Li Zhang and Jiwen Yang, Soochow University, China

Locally Linear Embedding (LLE) is a sort of powerful nonlinear dimensionality reduction algorithms.The basic idea behind the LLE method is that each data point and its neighbors lie on or close to a locally linear patch of the manifold if there is sufficient data. Then the local geometry of these patches is described by using linear coefficients which can reconstruct each data point from its neighbors. However, LLE operates in a batch way and its dimension reduction cannot be generalized to unseen samples. If a test sample arrives, LLE must run repeatedly and the former computational results are discarded. Thus, some incremental methods have been proposed for LLE to solve this problem. In these incremental methods, the neighbor number is globally fixed, which may result in selecting points from another linear space as neighbors. This paper presents LLE based on orthogonal matching pursuit (OMP) and applies it to classification tasks. In the classification tasks, dimensionality reduction on test samples is implemented by applying dimension reduction on training samples.The new LLE method could select a more appropriate

neighbors from the selected neighbors. OMP is applied to not only LLE for training samples, but also the incremental learning of LLE for test samples. Compared with other linear incremental methods, experimental results show that the proposed method is promising.

4:20PM *Hidden Markov Models Based Dynamic Hand Gesture Recognition with Incremental Learning Method [#N-14412]*

Meng Hu, Furao Shen and Jinxi Zhao, Nanjing University, China

This paper proposes a real-time dynamic hand gesture recognition system based on Hidden Markov Models with incremental learning method (IL-HMMs) to provide natural human computer interaction. The system is divided into four parts: hand detecting and tracking, feature extraction and vector quantization, HMMs training and hand gesture recognition, incremental learning. After quantized hand gesture vector being recognized by HMMs, incremental learning method is adopted to modify the parameters of corresponding recognized model to make itself more adaptable to the coming new gestures. Experiment results show that comparing with traditional one, the proposed system can obtain better recognition rates.

4:40PM *Long-Term Learning Behavior in a Recurrent Neural Network for Sound Recognition [#N-14458]*

Michiel Boes, Damiano Oldoni, Bert De Coensel and Dick Botteldooren, Ghent University, Belgium

In this paper, the long-term learning properties of an artificial neural network model, designed for sound recognition and computational auditory scene analysis in general, are investigated. The model is designed to run for long periods of time (weeks to months) on low-cost hardware, used in a noise monitoring network, and builds upon previous work by the same authors. It consists of three neural layers, connected to each other by feedforward and feedback excitatory connections. It is shown that the different mechanisms that drive auditory attention emerge naturally from the way in which neural activation and intra-layer inhibitory connections are implemented in the model. Training of the artificial neural network is done following the Hebb principle, dictating that "Cells that fire together, wire together", with some important modifications, compared to standard Hebbian learning. As the model is designed to be on-line for extended periods of time, also learning mechanisms need to be adapted to this. The learning needs to be strongly attention- and saliency-driven, in order not to waste available memory space for sounds that are of no interest to the human listener. The model also implements plasticity, in order to deal with new or changing input over time, without catastrophically forgetting what it already learned. On top of that, it is shown that also the implementation of shortterm memory plays an important role in the long-term learning properties of the model. The above properties are investigated and demonstrated by training on real urban sound recordings.

5:00PM *Study of Learning Entropy for Novelty Detection in Lung Tumor Motion Prediction for Target Tracking Radiation Therapy [#N-14729]*

Ivo Bukovsky, Noriyasu Homma, Matous Cejnek and Kei Ichiji, Czech Technical University in Prague, Czech Republic; Tohoku University, Japan; Tohoku University, Czech Republic

This paper presents recently introduced concept of Learning Entropy (LE) for time series and recalls the practical form of its evaluation in real time. Then, a technique that estimates the increased risk of prediction inaccuracy of adaptive predictors in real time using LE is introduced. On simulation examples using artificial signal and real respiratory time series, it is shown that LE can be used to evaluate the actual validity of the adaptive predicting model of time series in real time. The introduced technique is discussed as a potential approach to the improvement of accuracy of lung tumor tracking radiation therapy.

5:20PM *Opinion Retrieval through Unsupervised Topological Learning [#N-14876]*

Nicoleta Rogovschi and Nistor Grozavu, Paris Descartes University, France; Paris 13 University, France

Opinon Mining is the field of computational study of peopel's emotional behavior expressed in text. The purpose of this article is to introduce a new framework for emotion (opinon) mining based on topological unsupervised learning and hierarchical clustering. In contrast to supervised learning, the problem of clustering characterization in the context of opinion mining based on unsupervised learning is challenging, because label information is not available or not used to guide the learning algorithm. The algorithm described in this paper provides topological clustering of the opionon issued from the tweets, each cluster being associated to a prototype and a weight vector, reflecting the relevance of the data belonging to each clsuter. The proposed framework requires simple computational techniques and are based on the double local weighting self-organizing map (dlw-SOM) model and Hierarchical Clustering. The proposed framework has been used on a real dataset issued from the tweets collected during the 2012 french election compaign.

5:40PM *A Fast Incremental Kernel Principal Component Analysis for Data Streams. [#N-14888]*

Annie anak Joseph and Seiichi Ozawa, Kobe University, Japan

Kernel Principal Component Analysis (KPCA) is widely used feature extraction as it have been proven that KPCA is powerful in many areas in pattern recognition. Considering that the conventional KPCA should decompose a kernel matrix of all training data, this would be an unrealistic assumption for data streams in real-world applications. Therefore, in this paper, we propose an online feature extraction called Chunk Incremental Kernel Principal Component Analysis (CIKPCA) that can handle data streams in an incremental mode. In the proposed method, the training data are assumed to be given in a chunk of multiple data at one time. In CIKPCA, an eigen-feature space is updated by solving the eigenvalue decomposition once whenever a chunk of data is given. However, if a chunk size is large, a kernel matrix to be decomposed is also large, resulting in high computational time. Considering that not all the data are useful for the eigen-feature space learning, the data in a chunk are first selected based on the importance. Several benchmark data sets in the UCI machine learning repository are used to evaluate the performance of the proposed method. The experimental results show that our proposed method can accelerate the learning of the eigenfeature space compared to Takeuchi et al.'s IKPCA without reducing the recognition accuracy.

Special Session: ThN2-3 Neurodynamic Optimization

Thursday, July 10, 4:00PM-6:00PM, Room: 305B, Chair: Sanqing Hu and Yunong Zhang

4:00PM *A One-Layer Discrete-Time Projection Neural Network for Support Vector Classification [#N-14065]*

Wei Zhang and Qingshan Liu, Southeast University, China

This paper presents a one-layer discrete-time projection neural network described by difference equations for real-time support vector classification (SVC). The SVC is first formulated as a convex quadratic programming problem, and then a recurrent neural network with one-layer structure is designed for training the support vector machine. Furthermore, simulation results on two illustrative examples are given to demonstrate the effectiveness and performance of the proposed neural network.

4:20PM *A Novel Discrete-Time Learning Algorithm for Speech Enhancement Using Noise Constrained Parameter Estimation [#N-14144]*

Youshen Xia, Guiliang Lin and Weixing Zheng, Fuzhou University, China; University of Western Sydney, Australia

This paper proposes a novel discrete-time learning algorithm for speech enhancement of single-channel noisy speech signal, based on a noise constrained least squares estimate. Unlike existing learning algorithms for the noise constrained estimate, the proposed discrete-time learning algorithm has a low complexity and fast speed. Simulation results show that the proposed discrete-time learning algorithm has a faster speed than the existing learning algorithms for speech enhancement. Moreover, the proposed discrete-time learning algorithm has a good performance in having a significant gain in SNR at colored noise.

4:40PM *Performance Analysis of LVI-Based PDNN Applied to Real-Time Solution of Time-Varying Quadratic Programming [#N-14146]*

Yunong Zhang, Fangting Wu, Zhengli Xiao, Zhen Li and Binghuang Cai, Sun Yat-sen University, China; University of Pittsburgh, United States

This paper illustrates theoretical analysis and simulative verification on the performance of the linear-variational- inequality based primal-dual neural network (LVI-PDNN), which was designed originally for static quadratic programming (QP) problem solving but is now applied to time-varying QP problem solving. It is theoretically proved that the LVI-PDNN for solving the time-varying QP problem subject to equality, inequality and bound constraints simultaneously could only approximately approach the time-varying theoretical solution, instead of converging exactly. In other words, the steady-state error of the real-time solution can not decrease to zero. In order to better evaluate the time-varying situation, we investigate the upper bound of such an error and the global exponential convergence rate for the LVI-PDNN approaching its loose error bound. Computer simulations further substantiate the performance analysis of the LVI-PDNN exploited for real- time solution of the time-varying QP problem.

5:00PM *Model Predictive Control of Multi-Robot Formation Based on the Simplified Dual Neural Network [#N-14206]*

Xinzhe Wang, Zheng Yan and Jun Wang, Dalian University of Technology, China; The Chinese University of Hong Kong, China

This paper is concerned with formation control problems of multi-robot systems in framework of model predictive control. The formation control of robots herein is based on the leader-follower scheme. The followers are controlled by torques to track the desired trajectories to form and keep a formation. A model predictive control approach is proposed for solving the formation control problem, where the control problem is formulated as a dynamic quadratic optimization problem. A one-layer recurrent neural network called the simplified dual network is applied for computing the optimal control input in real time. Simulation results substantiate that the formation of robots can be well controlled by the proposed approach.

5:20PM *Neurodynamics-Based Model Predictive Control of Autonomous Underwater Vehicles in Vertical Plane [#N-14207]*

Zhiying Liu, Xinzhe Wang and Jun Wang, Dalian University of Technology, China; Dalian University of Technology and the Chinese University of Hong Kong, China

A model predictive control (MPC) method based on a recurrent neural network for Autonomous Underwater Vehicles (AUV) in vertical plane is presented in this paper. Both kinematic and dynamic models are considered in the set-point control of the AUV. A one-layer recurrent neural network called the general projection neural network is applied for real-time optimization. Simulation results are discussed to demonstrate the effectiveness and characteristics of the proposed model predictive control method.

5:40PM *A Single Layer Recurrent Neural Network For Pseudoconvex Optimization Subject to Quasiconvex Constraints [#N-14259]*

Jingjing Huang and Guocheng Li, Beijing Information Science and Technology University, China

This paper presents a single layer recurrent network for solving optimization problems with pseudoconvex objectives subject to quasiconvex constraints. The penalty method using a finite penalty parameter is applied for the design and analysis of the neural network. The lower bounder of the penalty parameter is given in order to guarantee the exact penalty property. It is rigorously proved that the neural network is globally convergent to the global optimal solution of the corresponding optimization problem. Simulation results are included to illustrate the performances of the proposed neural network.

6:00PM *Causality from Cz to C3/C4 or between C3 and C4 Revealed by Granger Causality and New Causality during Motor Imagery [#N-14627]*

Sanqing Hu, Hui Wang, Jianhai Zhang, Wanzeng Kong and Yu Cao, Hangzhou Dianzi University, China; The University of Massachusetts Lowell, United States

Interaction between different brain regions has received wide attention recently. Granger causality (GC) is one of the most popular methods to explore causality relationship between different brain regions. In 2011, Hu et al pointed out shortcomings and/or limitations of GC by using a large of number of illustrative examples and meanwhile proposed a new causality (NC) which is shown to be more reasonable and understandable than GC. Motor imagery (MI) is an important mental process in cognitive neuroscience and has received growing attention for a long time. However, there is few work about causality flow so far during MI based on scalp EEG. In this paper, we use scalp EEG to study causality flow during MI. The scalp EEGs are from 9 subjects in BCI competition IV held in 2008. We are interested in three regions: Cz (central area of the cerebral cortex), C3(left area of the cerebral cortex) and C4 (right area of the cerebral cortex) which are considered to be optimal locations for recognizing MI states in literature. We apply GC and NC to scalp EEG and find that i) there is strong directional connectivity from Cz to C3/C4 during left hand and right hand MI based on GC and NC. ii) During left hand MI, there is directional connectivity from C4 to C3 based on GC and NC. iii) During right hand MI, there is strong directional connectivity from C3 to C4 which is much clearly revealed by NC method than by GC method, that is, NC method largely improves the classification rate. iv) Our results suggest that NC method is demonstrated to be much better to reveal causal influence between different brain regions than GC method.

ThN2-4 Spiking Neural Networks II

Thursday, July 10, 4:00PM-6:00PM, Room: 305C, Chair: Zeng-Guang Hou

4:00PM *Magnitude Comparison in Analog Spiking Neural Assemblies [#N-14269]*

Jose Oliveira-Neto, Felipe Duque-Belfort, Rafael Cavalcanti-Neto and Joao Ranhel, Universidade Federal de Pernambuco, Brazil

Spiking neural systems can represent external stimuli and internal states by means of sets of neurons firing together, the so-called cell assemblies. Neural assembly computing (NAC) is an approach that investigates how spiking neural assemblies represent things and states of the world, how interaction among assemblies results in information processing, computation and behavior. Mainly, NAC deals with digital assemblies in which all-or-none cell members are firing. The notion of analog assemblies is introduced, describing sets of neurons that represent something proportionally to their driving stimuli. Interactions among digital and analog cell assemblies create a rich computational environment. In this paper a spiking neural network that compares the magnitude of two analog assemblies is presented.

4:20PM *Spike-Timing Dependent Morphological Learning for a Neuron with Nonlinear Active Dendrites [#N-14480]*

Phyo Phyo San, Shaista Hussain and Arindam Basu, Nanyang Technological University, Singapore

It has been shown earlier that simple abstraction of a neuron with nonlinear active dendrites and binary synapses has a higher computational power than a neuron with linearly summing dendrites. However, it has only been used to classify high dimensional binary patterns of mean spike rates. In this paper, a nonlinear dendritic (NLD) neuron equipped with binary synapses that is able to learn temporal features of spike input patterns is presented. Since the synapses are binary, learning happens through formation and elimination of connections between the inputs and the dendritic branches thus modifying the structure or "morphology" of the cell. A morphological learning algorithm inspired by the 'Tempotron'- a recently proposed temporal learning algorithm-is presented in this work. Experimental results indicate that our neuron with NLD with 1-bit synapses can obtain similar accuracy as a traditional Tempotron with 4-bit synapses in classifying a population of single spike latency patterns. Hence, the proposed method is better suited for robust hardware implementation in the presence of statistical variations.

4:40PM *Improved Predictive Personalized Modelling with the Use of Spiking Neural Network System and a Case Study on Stroke Occurrences Data [#N-14525]*

Muhaini Othman, Nikola Kasabov, Enmei Tu, Valery Feigin, Rita Krishnamurthi, Zeng-Guang Hou, Yixiong Chen and Jin Hu, Auckland University of Technology, New Zealand; Shanghai Jiao Tong University, China; Chinese Academy of Sciences, China

This paper is a continuation of previous published work by the same authors on Personalized Modelling and Evolving Spiking Neural Network Reservoir architecture (PMeSNNr). The focus is on improvement of predictive modeling methods for the stroke occurrences case study utilizing an enhanced NeuCube architecture. The adaptability of the new architecture leads towards understanding feature correlations that affect the outcome of the study and extracts new knowledge from hidden patterns that reside within the associations. Through this new method, estimation of the earliest time point for stroke prediction is possible. This study also highlighted the improvement from designing a new experimental dataset compared to previous experiments. Comparative experiments were also carried out using conventional machine learning algorithms such as kNN, wkNN, SVM and MLP to prove that our approach can result in much better accuracy level.

5:00PM *Signature of an Anticipatory Response in Area V1 as Modeled by a Probabilistic Model and a Spiking Neural Network [#N-14746]*

Bernhard A. Kaplan, Mina A. Khoei, Anders Lansner and Laurent U. Perrinet, Royal Institute of Technology and Karolinska Institute, Sweden; Fance Aix-Marseille University, France; Stockholm Universtity, Sweden; France Aix-Marseille University, France

As it is confronted to inherent neural delays, how does the visual system create a coherent representation of a rapidly changing environment? In this paper, we investigate the role of motion-based prediction in estimating motion trajectories compensating for delayed information sampling. We study how anisotropic diffusion of information may explain the development of anticipatory response as recorded in a neural populations to an approaching stimulus. We validate this idea using an abstract probabilistic framework and a spiking neural network (SNN). Inspired by a mechanism proposed by Nijhawan, we use a Bayesian particle filter framework and introduce a diagonal motion-based prediction model which extrapolates the estimated response to a delayed stimulus in the direction of the trajectory. In the SNN, we use this anisotropic connectivity as mechanism for motion-extrapolation. Consistent with recent experimental data collected in extracellular recordings of macaque V1, we have explored how anticipatory responses may depend on the information accumulated along the trajectory. We show that both our probabilistic framework and the SNN model can replicate the experimental data qualitatively. Most importantly, we highlight requirements for the development of a trajectory-dependent anticipatory response, and in particular the anisotropic nature of the connectivity pattern which leads to motion extrapolation. Nijhawan R. et al, "Compensating time delays with neural predictions: are predictions sensory or motor?" Phil Trans of the Royal Society A, 2009 Benvenuti et al. "Building a directional anticipatory response along the motion trajectory in monkey area V1' Abstracts of Society For Neuroscience, 2011

5:20PM *Predicting Temporal Sequences Using an Event-Based Spiking Neural Network Incorporating Learnable Delays [#N-14750]*

Tingting Gibson, James Henderson and Janet Wiles, University of Queensland, Australia

This paper presents a novel paradigm for a spiking neural network to forecast temporal sequences. The key to the approach is a new model of a spiking neuron that can make multi-step predictions, using learnable temporal delays at both dendrites and axons. This model is able to learn the temporal structure of space- time events, adaptable to multiple scales, with the neurons able to function asynchronously to predict future events in a video sequence. This approach contrasts with conventional neural network approaches that use fixed time steps and iterative prediction. Simulations were conducted to compare the new model to a conventional iterative paradigm on motion sequences from a frame-free event- driven Dynamic Vision Sensor (DVS128, 16k pixels), showing that the new approach consistently has a low prediction error while the iterative paradigm is affected by propagated errors.

5:40PM *Feasibility of NeuCube SNN Architecture for Detecting Motor Execution and Motor Intention for Use in BCI Applications [#N-14878]*

Denise Taylor, Nathan Scott, Nikola Kasabov, Elisa Capecci, Enmei Tu, Nicola Saywell, Yixiong Chen, Jin Hu and Zeng-Guang Hou, AUT University, New Zealand; Shanghai Jiao Tong University, China; Chinese Academy of Sciences, China

The paper is a feasibility analysis of using the recently introduced by one of the authors spiking neural networks architecture NeuCube for modelling and recognition of complex EEG spatio-temporal data related to both physical and intentional (imaginative) movements. The preliminary experiments reported in the paper suggest that NeuCube is much more efficient for the task than standard machine learning techniques, resulting in higher recognition accuracy, a better adaptability to new data, a better interpretation of the models, leading to a better understanding of the brain data and the processes that generated it.

ThN2-5 Signal and Image Processing

Thursday, July 10, 4:00PM-6:00PM, Room: 305D, Chair: Pau-Choo Chung

4:00PM *On-Line Gaussian Mixture Density Estimator for Adaptive Minimum Bit-Error-Rate Beamforming Receivers [#N-14008]*

Sheng Chen, Xia Hong and Chris Harris, University of Soutahmpton, United Kingdom; University of Reading, United Kingdom

We develop an on-line Gaussian mixture density estimator (OGMDE) in the complex-valued domain to facilitate adaptive minimum bit-error-rate (MBER) beamforming receiver for multiple antenna based space-division multiple-access systems. Specifically, the novel OGMDE is proposed to adaptively model the probability density function of the beamformer's output by tracking the incoming data sample by sample. With the aid of the proposed OGMDE, our adaptive beamformer is capable of updating the beamformer's weights sample by sample to directly minimize the achievable bit error rate (BER). We show that this OGMDE based MBER beamformer outperforms the existing on-line MBER beamformer, known as the least BER beamformer, in terms of both the convergence speed and the achievable BER.

4:20PM *The Neoteric Feature Extraction Method of Epilepsy EEG Based on the Vertex Strength Distribution of Weighted Complex Network [#N-14102]*

Fenglin Wang, Qingfang Meng and Yuehui Chen, University of Jinan, China

The study of epilepsy detection has great clinical significance. The focus of this study is feature extraction method, which has significant impacts on the performance of epilepsy detection. Recently, the statistic properties of complex network show ability to describe the dynamics of nonlinear time series. In this paper, a feature extraction method of epileptic EEG, based on statistical properties of weighted complex network, is proposed. The weighted network of epileptic EEG is first constructed and the vertex strength distribution of the converted network is studied. Then the weighted mean value of the vertex strength distribution is defined and extracted as the classification feature. Experimental results indicate that the extracted feature can clearly reflect the difference between ictal EEGs and interictal EEGs and the single feature classification based on extracted feature gets higher classification accuracy up to 95.50%.

4:40PM *Real-Time Hand Gesture Recognition with Kinect for Playing Racing Video Games [#N-14190]*

Yanmin Zhu and Bo Yuan, Tsinghua University, China

This paper presents a Kinect based hand gesture recognition system that can effectively recognize both one-hand and two-hand gestures. It is robust against the disturbance of complex background and objects such as the faces and hands of other people by exploiting the depth information and carefully choosing the region of interest (ROI) in the process of tracking. The recognition module is implemented using template matching and other light weight techniques to reduce the computational complexity. In the experiments, this system is tested on real world tasks from controlling the slide show in PowerPoint to playing the highly intense racing video game Need for Speed. The practical performance confirms that our system is both effective in terms of robustness and versatility and efficient for various real-time applications.

5:00PM *EEG Energy Analysis for Evaluating Consciousness Level Using Dynamic MEMD [#N-14535]*

Yunchao Yin, Gaochao Cui, Toshihisa Tanaka and Jianting Cao, Saitama Institute of Technology, Japan; Tokyo University of Agriculture and RIKEN, Japan

Analysis of electroencephalography (EEG) energy is a useful technique in the brain signal processing. In this paper, we present a novel data analysis method based on dynamic multivariate empirical mode decomposition (D-MEMD) algo- rithm to analyze EEG energy of three different conscious states such as normal awake, comatose and brain death. By using Dynamic MEMD, we can not only denoise the original EEG data but also calculate the EEG energy of subjects in a dynamic time series. Moreover, from the result, we distinguish three consciousness levels. The results of healthy subject in normal awake, comatose patient and brain death will be shown. The analyzed results illustrate the effectiveness and performance of the proposed method in calculation of EEG energy for evaluating consciousness level.

5:20PM *Alzheimer's Disease Classification Based on Gait Information [#N-14617]*

Wei-Hsin Wang, Yu-Liang Hsu, Ming-Chyi Pai, Chun-Yao Wang, Chien-Wen Lin, Hao-Li Wu and Pau-Choo Chung, National Cheng Kung University, Taiwan; National Cheng Kung University Hospital, Taiwan

Alzheimer's disease (AD) is becoming one of the major diseases of the elderly. Traditionally, patients take questionnaires or do some balance tests for clinical evaluation. However, results with such evaluation are subjective. For more objective quantitative measurement, this paper uses an inertial-sensor-based device to measure the gait information while participants walking. In the experiment, the participants are asked to walk on a 40m strike line and take single-task and dual-task tests. In the dual-task test, the participants are asked to count down from 100. This paper presents a stride detection algorithm to automatically acquire gait information of each gait cycle from the acceleration and angular velocity signals. Features are calculated from those inertial signals. After feature generation, we do feature selection to select the significant feature. Then, a probabilistic neural networks (PNNs) is used to classify if the participants suffer from AD. In this paper, we provide an objective way to evaluate the situation of the participants. The experimental results successfully validate the effectiveness of the proposed device and the proposed algorithm with an overall classification accuracy rates are 63.33% and 70.00% in women and men group, respectively.

5:40PM *Architectural Distortion Detection from Mammograms Using Support Vector Machine [#N-14882]*

Orawan Netprasat, Sansanee Auephanwiriyakul and Nipon Theera-Umpon, Chiang Mai University, Thailand

One of the leading diseases in women is breast cancer. The detection in an earlier stage is done by indicating the presence of architectural distortion (AD). An AD detection system with support vector machine is developed in this research. The 15 features are extracted from the fuzzy co-occurrence matrix and fractal dimension. The principal component analysis is also implemented to help in feature redundancy reduction. We found out that the best system for the training data set yields 91.67 % correct AD classification with 0.93 sensitivity of detecting AD and 0.91 specificity of detecting true negative. The best result of the blind test mammograms is at 100.00 % correct AD classification with approximately 16 false positive areas per image.

ThN2-6 Neural Modeling and Control

Thursday, July 10, 4:00PM-6:00PM, Room: 305E, Chair: Hongliang Li

4:00PM *Data-Driven Iterative Adaptive Dynamic Programming Algorithm for Approximate Optimal Control of Unknown Nonlinear Systems [#N-14161]*

Hongliang Li, Derong Liu, Ding Wang and Chao Li, Chinese Academy of Sciences, China

In this paper, we develop a data-driven iterative adaptive dynamic programming algorithm to learn offline the approximate optimal control of unknown discrete-time nonlinear systems. We do not use a model network to identify the unknown system, but utilize the available offline data to learn the approximate optimal control directly. First, the data-driven iterative adaptive dynamic programming algorithm is presented with a convergence analysis. Then, the error bounds for this algorithm are provided considering the approximation errors of function approximation structures. To implement the developed algorithm, two neural networks are used to approximate the state-action value function and the control policy. Finally, two simulation examples are given to demonstrate the effectiveness of the developed algorithm.

4:20PM *Hybrid Neural Networks for Gasoline Blending System Modeling [#N-14189]*

Wen Yu and Xiaoou Li, CINVESTAV-IPN, Mexico

Gasoline blending is an important unit operation in gasoline industry. A good model for the blending system is beneficial for supervision operation, prediction of the gasoline qualities and performing model based optimal control. Gasoline blending process involves two types of proprieties: static blending and dynamic in the blending tanks. The blending process cannot be modeled exactly, because it does not follow ideal mixing rules in practice. In this paper we propose a hybrid neural network, which uses static and dynamic neural networks to approximate the blending properties. Numerical simulations are provided to illustrate the neuro modeling approach.

4:40PM *Adaptive Self-Constructing Radial-Basis-Function Neural Control for MIMO Uncertain Nonlinear Systems with Unknown Disturbances [#N-14433]*

Ning Wang, Bijun Dai, Yancheng Liu and Min Han, Dalian Maritime University, China; China CNR Corporation Limited, China; Dalian University of Technology, China

In this paper, an adaptive self-constructing RBF neural control (AS-RBFNC) scheme for trajectory tracking of MIMO uncertain nonlinear systems with unknown time-varying disturbances is proposed. System uncertainties and unknown dynamics can be exactly identified online by a self-constructing RBF neural network (SC-RBFNN) which is implemented by employing dynamically constructive hidden nodes according to the structure learning criteria including hidden node generating and pruning. The globally asymptotical stability of the entire AS- RBFNC control system is derived from Lyapunov approach.

5:00PM *Robust Structure Selection of Radial Basis Function Networks for Nonlinear System Identification [#N-14526]*

Pan Qin and Han Min, Dalian University of Technology, China

This paper proposed a robust structure selection method of radial basis function (RBF) networks for nonlinear system identification problems. A greedy algorithm is first employed by combining information criteria with the forward stepwise selection to choose the RBF network structures. Then, a robust selection procedure, which can select a concise and generalized network structure, is developed based on the forward stepwise selection and the subsampling method. Finally, a numerical example is given to illustrate the effectiveness of the proposed method by using the disturbance storm time index data.

5:20PM *Neural Control for a Solid Waste Incinerator [#N-14765]*

Rocio Carrasco, Edgar Sanchez, Riemann Ruiz and Catherine Cadet, CINVESTAV, Mexico; ITESO AC University, Mexico; GIPSA-lab, France

In this work, a neural control scheme to regulate carbon monoxide (CO) and nitrogen oxides (NOx) emissions for a solid waste incinerator is proposed. Carbon monoxide emissions are avoided by oxygen regulation in the incinerator; nevertheless nitrogen oxides emissions are difficult to control because the sludge composition varies continuously. The air flow is selected to be the control input because it have a great influence in CO and NOx formation. The air flow can guarantee a complete combustion and therefore, a good incineration quality because it avoids pollutant formation. In order to obtain the sludge combustion model, it is proposed to use a recurrent high order neural network (RHONN), which is trained with an extended Kalman filter (EKF) algorithm. The proposed neural controler performance is illustrated via simulations.

5:40PM *Reservoir-Based Online Adaptive Forward Models with Neural Control for Complex Locomotion in a Hexapod Robot [#N-14074]*

Poramate Manoonpong, Sakyasingha Dasgupta, Dennis Goldschmidt and Florentin Woergoetter, University of Southern Denmark, Denmark; University of Goettingen, Germany; University of Zurich, Switzerland

Walking animals show fascinating locomotor abilities and complex behaviors. Biological study has revealed that such complex behaviors is a result of a combination of biomechanics and neural mechanisms. While biomechanics allows for flexibility and a variety of movements, neural mechanisms generate locomotion, make predictions, and provide adaptation. Inspired by this finding, we present here an artificial bio-inspired walking system which combines biomechanics (in terms of its body and leg structures) and neural mechanisms. The neural mechanisms consist of 1) central pattern generator-based control for generating basic rhythmic patterns and coordinated movements, 2) reservoir-based adaptive forward models with efference copies for sensory prediction as well as state estimation, and 3) searching and elevation control for adapting the movement of an individual leg to deal with different environmental conditions. Simulation results show that this bio-inspired approach allows the walking robot to perform complex locomotor abilities including walking on undulated terrains, crossing a large gap, as well as climbing over a high obstacle and a fleet of stairs.

Friday, July 11, 8:10AM-10:10AM

Special Session: FrN1-1 Concept Drift, Domain Adaptation & Learning in Dynamic Environments II

Friday, July 11, 8:10AM-10:10AM, Room: 308, Chair: Giacomo Boracchi and Manuel Roveri

8:10AM *Resistant Learning on the Envelope Bulk for Identifying Anomalous Patterns [#N-14195]*

Shin-Ying Huang, Fang Yu, Rua-Huan Tsaih and Yennun Huang, Research Center for Information Technology Innovation, Academia Sinica, Taiwan; National Chengchi University, Taiwan

Anomalous patterns are observations that lie far away from the fitting function deduced from the bulk of the given observations. This work addresses the research issue to effectively identify anomalous patterns in both contexts of resistant learning, where there is no assumption about the fitting function form, and of changing environments. The resistant learning means that the learning procedure is not impacted significantly by the outlying observations. In literature, there is the resistant learning with searching a near-perfect fitting function for identifying the bulk of the majority of observations. However, the learning algorithm with searching a near-perfect fitting function suffers from time inefficiency. To effectively identify anomalous patterns in both contexts of resistant learning and changing environments, this study proposes a new resistant learning algorithm integrating the envelope module with the moving window strategy that learns to evolve a nonlinear fitting function wrapped with a constant-width envelope for containing the majority of observations and thus identifying anomalous patterns. An illustrative experiment is set up to justify the effectiveness of the envelope module and the experimental result shows the positive promise.

8:30AM *A Multi-Objective Ensemble Method for Online Class Imbalance Learning [#N-14291]*

Shuo Wang, Leandro L. Minku and Xin Yao, School of Computer Science, University of Birmingham, United Kingdom

Online class imbalance learning is an emerging learning area that combines the challenges of both online learning and class imbalance learning. In addition to the learning difficulty from the imbalanced distribution, another major challenge is that the imbalanced rate in a data stream can be dynamically changing. OOB and UOB are two state-of-the-art methods for online class imbalance problems. UOB is better at recognizing minority-class examples when the imbalance rate does not change much over time, while OOB is more prepared for the case with a dynamic rate. Aiming for an effective method for both static and dynamic cases, this paper proposes a multi-objective ensemble method MOSOB that combines OOB and UOB. MOSOB finds the Pareto-optimal weights for OOB and UOB at each time step, to maximize minority-class recall and majority-class recall simultaneously. Experiments on five real-world data applications show that MOSOB performs well in both static and dynamic data streams. Furthermore, we look into its performance on a group of highly imbalanced data streams. To respond to the minority class within 10000 time steps, the imbalance rate can be as low as 0.1% for easy data streams; at least 3% of imbalance rate is required to classify difficult data streams.

8:50AM *The Parzen Kernel Approach to Learning in Non-Stationary Environment [#N-14688]*

Lena Pietruczuk, Leszek Rutkowski, Maciej Jaworski and Piotr Duda, Czestochowa University of Technology, Poland

In this paper a method for nonparametric regression estimation in non-stationary environment is presented. The Parzen kernels are used to design the recursive general regression neural networks to track changes of non-stationary system under non-stationary noise. The probabilistic properties of the proposed method are investigated. Experimental results are presented and discussed.

9:10AM *A Novel Application of Hoeffding's Inequality to Decision Trees Construction for Data Streams [#N-14689]*

Piotr Duda, Maciej Jaworski, Lena Pietruczuk and Leszek Rutkowski, Czestochowa University of Technology, Poland

Decision trees are the commonly applied tools in the task of data stream classification. The most critical point in decision tree construction algorithm is the choice of the splitting attribute. In majority of algorithms existing in literature the splitting criterion is based on statistical bounds derived for split measure functions. In this paper we propose a totally new kind of splitting criterion. We derive statistical bounds for arguments of split measure function instead of deriving it for split measure function itself. This approach allows us to properly use the Hoeffding's inequality to obtain the required bounds. Based on this theoretical results we propose the Decision Trees based on the Fractions Approximation algorithm (DTFA). The algorithm exhibits satisfactory results of classification accuracy in numerical experiments. It is also compared with other existing in literature methods, demonstrating noticeably better performance.

9:30AM *NEVE++: A Neuro-Evolutionary Unlimited Ensemble for Adaptive Learning [#N-14710]*

Tatiana Escovedo, Abs da Cruz Andre, Koshiyama Adriano, Melo Rubens and Vellasco Marley, PUC-Rio, Brazil

In our previous works, we proposed NEVE, a model that uses a weighted ensemble of neural network classifiers for adaptive learning, trained by means of a quantum-inspired evolutionary algorithm (QIEA). We showed that the neuro-evolutionary classifiers were able to learn the dataset and to quickly respond to any drifts on the underlying data. Now, we are particularly interested on analyzing the influence of an unlimited ensemble, instead of the limited ensemble from NEVE. For that, we modified NEVE to work with unlimited ensembles, and we call this new algorithm NEVE++. To verity how the unlimited ensemble influences the results, we used four different datasets with concept drift in order to compare the accuracy of NEVE and NEVE++, using two other existing algorithms as reference.

9:50AM *Exploiting Self-Similarity for Change Detection [#N-14766]*

Giacomo Boracchi and Roveri Manuel, Politecnico di Milano, DEIB, Italy

Time-series data are often characterized by a large degree of self-similarity, which arises in application domains featuring periodicity or seasonality. While self-similarity has shown to be an effective prior for modeling real data in the signal and image-processing literature, it has received much less attention in time-series literature, where only few works leveraging the self-similarity for anomaly detection have been presented. Here we introduce a novel change-detection test to detect structural changes in time series by analyzing their self- similarity. The core of the proposed solution is the definition of a change indicator to quantitatively assesses the self-similarity of the time-series data over time. In particular, the change indicator is obtained by comparing each patch to be analyzed with its most similar counterpart in a change-free training set. Experimental results on the flow measurements in the water distribution network of the Barcelona city show the effectiveness of the proposed solution.

Special Session: FrN1-2 Neural Networks Applied to Vision and Robotics II

Friday, July 11, 8:10AM-10:10AM, Room: 305A, Chair: Jose Garcia Rodriguez and Jorge Azorin

8:10AM *Color Space Selection for Self-Organizing Map Based Foreground Detection in Video Sequences [#N-14073]*

Francisco Javier Lopez-Rubio, Ezequiel Lopez-Rubio, Rafael Marcos Luque-Baena, Enrique Dominguez and Esteban J. Palomo, University of Malaga, Spain; University of Extremadura, Spain

The selection of the best color space is a fundamental task in detecting foreground objects on scenes. In many situations, especially on dynamic backgrounds, neither grayscale nor RGB color spaces represent the best solution to detect foreground objects. Other standard color spaces, such as YCbCr or HSV, have been proposed for background modeling in the literature; although the best results have been achieved using diverse color spaces according to the application, scene, algorithm, etc. In this work, a color space and color component weighting selection process is proposed to detect foreground objects in video sequences using self-organizing maps. Experimental results are also provided using well known benchmark videos.

8:30AM *Improving Robot Vision Models for Object Detection Through Interaction [#N-14304]*

Juergen Leitner, Alexander Foerster and Juergen Schmidhuber, Dalle Molle Institute for AI (IDSIA), Switzerland

We propose a method for learning specific object representations that can be applied (and reused) in visual detection and identification tasks. A machine learning technique called Cartesian Genetic Programming (CGP) is used to create these models based on a series of images. Our research investigates how manipulation actions might allow for the development of better visual models and therefore better robot vision. This paper describes how visual object representations can be learned and improved by performing object manipulation actions, such as, poke, push and pick-up with a humanoid robot. The improvement can be measured and allows for the robot to select and perform the `right' action, i.e. the action with the best possible improvement of the detector.

8:50AM *Image-Based Global Localization Using VG-RAM Weightless Neural Networks [#N-14802]*

Lauro J. Lyrio Junior, Thiago Oliveira-Santos, Avelino Forechi, Lucas Veronese, Claudine Badue and Alberto F. De Souza, Universidade Federal do Espirito Santo, Brazil

Mapping and localization are fundamental problems in autonomous robotics. Autonomous robots need to know where they are in their area of operation to navigate through it and to perform activities of interest. In this paper, we propose an Image-Based Global Localization (VibGL) system that uses Virtual Generalizing Random Access Memory Weightless Neural Networks (VG-RAM WNN). For mapping, we employ a VG-RAM WNN that learns the world positions associated with the images captured along a trajectory. During the localization, new images from the trajectory are presented to the VG-RAM WNN, which outputs their positions in the world. We performed experiments with our VibGL system applied to the problem of localizing an autonomous car. Our experimental results show that the system is able to learn large maps (several kilometers in length) of real world environments and perform global localization with median pose precision of about 3m. Considering a tolerance of 10m VibGL is able to localize the car 95% of the time.

9:10AM *EEG Based Artificial Learning of Motor Coordination for Visually Inspired Task Using Neural Networks [#N-14899]*

Shreyasi Datta, Anwesha Khasnobish, Amit Konar, D. N. Tibarewala and Atulya Nagar, Jadavpur University, India; Jadavpur University, India; Liverpool Hope University, United Kingdom

Damage in parietal and/or motor cortex of the brain can lead to inability in proper visuo-motor coordination, hampering movement planning and execution. The objective of this work is to predict joint coordinates of hand by sequential prediction of the parietal and motor cortex Electroencephalogram (EEG) features from their occipital counterparts using artificial neural networks (ANNs). EEG signals during hand movement execution are acquired from occipital, parietal and motor cortical regions and the joint coordinates of hand are acquired using Kinect sensor. The acquired EEG signals are preprocessed followed by extraction of wavelet features and selection of the best features using Principal Component Analysis. The EEG features originating from one brain region are mapped to the features of another brain region using regression analysis on artificial neural networks with Back Propagation learning. The mapped motor cortical EEG signals are finally used to predict the hand joint coordinates using Back Propagation learning based ANN. The performances of various weight adaptation techniques for Back Propagation learning are evaluated. Regression analysis results indicate that Levenberg-Marquardt optimization based weight adaptation performed best in terms of mean squared error, slope of the best linear fit and correlation coefficient between the original values and predicted results.

9:30AM *Serotonin and Dopamine Systems: Internal Areas and Sequential Tasks [#N-14920]*

Dongshu Wang, Yihai Duan and Juyang Weng, Zhengzhou University, China; Michigan State University, United States

Serotonin and dopamine transmitters are synthesized in the lower brain but are transmitted widely to many areas of the brain. Emergent representations are critical in understanding their effects. In our prior work, their effects on internal, non-motor neurons are studied for pattern recognition tasks only. In this paper, we study their effects on sequential tasks -- robot navigation with different settings. They are sequential tasks because the outcome of behavior depends on not only the current behavior as in pattern recognition but also the previous behaviors (e.g., previous navigational trajectories). Analytically, we show that the serotonin and dopamine systems affect the performance of sequential tasks in a compounded way. Experimentally, we show that the effect on the learning rate of feature neurons (in the Y area) allows the agent to approach the friend and avoid the enemy faster as

compounding effects of sequential states. Further, we tested the effect of punishment and reward schedule with the same initial locations. We also experimented the effect of punishment and reward schedule with random initial locations. These experiments all indicated that the reinforcement learning via the serotonin and the dopamine systems is beneficial for developing desirable behaviors in this set of sequential tasks -- staying close to its friend and away from its enemy. As far as we know, this is the first work that investigates the effects of reinforcer (via serotonin and dopamine) on internal neurons for sequential tasks.

Special Session: FrN1-3 Complex-Valued Neural Networks

Friday, July 11, 8:10AM-10:10AM, Room: 305B, Chair: Akira Hirose and Suresh Sundaram

8:10AM *An Introduction to Complex-Valued Recurrent Correlation Neural Networks [#N-14160]*

Marcos Eduardo Valle, University of Campinas, Brazil

In this paper, we generalize the bipolar recurrent correlation neural networks (RCNNs) of Chiueh and Goodman for complex-valued vectors. A complex-valued RCNN (CV-RCNN) is characterized by a possible non-linear function which is applied on the real part of the scalar product of the current state and the fundamental vectors. Computational experiments reveal that some CV-RCNNs can implement associative memories with high-storage capacity. Furthermore, these CV-RCNNs exhibit an excellent noise tolerance.

8:30AM *The HC Calculus, Quaternion Derivatives and Caylay-Hamilton Form of Quaternion Adaptive Filters and Learning Systems [#N-14215]*

Yili Xia, Cyrus Jahanchahi, Dongpo Xu and Danilo Mandic, Southeast University, China; Imperial College London, United Kingdom

We introduce a novel and unifying framework for the calculation of gradients of both quaternion holomorphic functions and nonholomorphic real functions of quaternion variables. This is achieved by considering the isomorphism between the quaternion domain H and the bivariate complex domain C*C, and by exploiting complex calculus to simplify the quaternion gradient calculation. The validation of the proposed HC calculus is performed against the existing HR calculus, and its convenience is illustrated in the context of gradient-based quaternion optimisation as well as in adaptive learning systems. Quaternion adaptive filtering algorithms and a dynamical perceptron update are next derived based on the bivariate complex representation of quaternions and the HC calculus. Simulations on both synthetic and real-world multidimensional signals support the analysis.

8:50AM *Stability Condition for Discrete Time Multi-Valued Recurrent Neural Networks in Asynchronous Update Mode [#N-14393]*

Wei Zhou and Jacek M. Zurada, Southwest University for Nationalities, China; University of Louisville, United States

This paper discusses the stability condition for discrete time multi-valued (MVN) recurrent neural networks in asynchronous update mode. In existing research literature, the MVN network in asynchronous update mode has been found convergent if its weight matrix is Hermitian with nonnegative diagonal entries. However, the new theorem and proof presented here show that weight matrix with zero diagonal entries can't guarantee the network stability. Simulation results are used to illustrate the theory.

9:10AM *A New Stability Condition for Discrete Time Recurrent Neural Networks with Complex-Valued Linear Threshold Neurons [#N-14395]*

Wei Zhou and Jacek M. Zurada, Southwest University for Nationalities, China; University of Louisville, United States

This paper discusses the stability condition for discrete time recurrent neural networks (RNNs) with complex-valued linear threshold (CLT) neurons. The energy-function method is very useful for complex-valued RNNs study, especially for multi-stable RNNs. In addition to properties of CLT RNNs discussed in earlier work, a new stability condition is offered here by virtue of a lower-bounded energy function. Simulation results are presented to illustrate the theory.

9:30AM *Ultra-Short-Pulse Acoustic Imaging Using Complex-Valued Spatio-Temporal Neural-Network for Null-Steering: Experimental Results [#N-14509]*

Kotaro Terabayashi and Akira Hirose, The University of Tokyo, Japan

This paper reports experimental results of a wideband acoustic imaging method based on power-inversion adaptive array (PIAA) scheme realized by a complex-valued spatio-temporal neural network (CVSTNN). For acoustic imaging with a high resolution in the range direction (direction of propagation), used pulse should be short. A short pulse has a wide frequency band, which is also favorable for avoidance of target breaking through acoustic resonance. However, because of the wide bandwidth, conventional adaptive arrays often fail in beamforming or null steering. We combine a CVSTNN and PIAA to realize a precise null steering. Experiments demonstrate that the CVSTNN-PIAA method presents a higher resolution than conventional methods.

9:50AM *Finite Convergence of the Learning Algorithms for a Modified Multi-Valued Neuron [#N-14510]*

Dongpo Xu and Shuang Liang, Harbin Engineering University, China

The multi-valued neuron (MVN) has a strong multiclassification ability. However, the MVN learning algorithms require the complex-valued learning rate and depends on the unknown optimal weights. To address this issue, we introduce a modified MVN that centers the neuron state in each sector. The learning algorithms of the modified MVN are able to reuse the real-valued learning rate and eliminate the dependencies on the optimal weights. We prove the convergence of the modified MVN learning algorithms with real-valued learning rate.

FrN1-4 Visual Systems

Friday, July 11, 8:10AM-10:10AM, Room: 305C, Chair: Zeng-Guang Hou

8:10AM *V4 Neural Network Model for Visual Saliency and Discriminative Local Representation of Shapes [#N-14058]*

Hui Wei and Zheng Dong, Fudan University, China

Visual area V4 lies in the middle of the ventral visual pathway in the primate brain. It is an intermediate stage in the visual processing for object discrimination. It plays an important role in the neural mechanism of visual attention and shape recognition. V4 neurons exhibit selectivity for salient features of contour conformation. In this paper, we propose a novel model of V4 neurons based on a multilayer neural network inspired by recent studies on V4. Its low-level layers consist of computational units simulating simple cells and complex cells in the primary visual cortex. These layers extract preliminary visual features including edges and orientations. The V4 computational units calculate the entropy of the extracted features as a measure of visual saliency. The salient features are then selected and encoded with a layer of Restricted Boltzmann Machine to generate an intermediate representation of object shapes. The model was evaluated in shape distinction, handwritten digits classification, feature detection, and feature matching experiments. The results demonstrate that this model generates discriminative local representation of object shapes. It provides clues to understand the high level representation of visual stimuli in the brain.

8:30AM *Binocular Visual Servoing Based on PID Neural Network [#N-14282]*

Guoyou Li and Xin Wang, Key Laboratory of Industrial Computer Control Engineering of Hebei Province, Yanshan University, China

The PID neural network was introduced into the control of the robot for image- based binocular visual servo control system with hand-eye model, and a controller was designed which combined the PI motion controller with the PID neural network controller in this paper. PI motion controller gives the desired velocity of the robot joints based on the image errors, and obtains the joint torque from the neural network PID controller. And the torque drives the robot reaching a desired position and orientation. The Lyapunov theory is used to prove asymptotic stability of the PI motion controller. And we compared the tracking performance of BP neural network with PID neural network. Simulation results show the effectiveness of this method.

8:50AM *Visual Saliency via Loss Coding [#N-14361]*

Hao Zhu and Biao Han, 3M Cogent Beijing, China; Universite deToulouse, France

A novel and effective bottom-up saliency model inspired by the recent findings of the early vision system is proposed. The lossy coding length, which resembles the neural cost in the hierarchical structure of human vision system, is exploit to measure saliency. We show that the proposed efficient coding network can be considered as the coding process in the early vision system. The sparse coding process in simple cells of the primary visual cortex and a dimensionality reduction process via the principal component analysis are integrated in the proposed network. The saliency value at each image pixel is computed based on the residual of the coding process. The proposed biological-inspired saliency model is evaluated on two different eye-tracking datasets against several state-of-the-art algorithms. Experimental results demonstrate the effectiveness, efficiency as well as robustness of the proposed model, and bear out the hypothesis of lossy coding for visual saliency.

9:10AM *Border Ownership in a Nano-Neuromorphic Circuit Using Nonlinear Dendritic Computations [#N-14504]*

Chih-Chieh Hsu and Alice Parker, University of Southern California, United States

We present an electronic cortical neuron with nonlinear dendritic computations that performs border-ownership assignment. The circuit is simulated using a carbon nanotube field-effect transistor SPICE model. We demonstrate that our neuron can distinguish convex and concave contours, selectively respond to a figure based on the contour and/or disparity cues, and transform this neural information into a border-ownership signal. We demonstrate that a dendritic spike is key to contour detection and increases the robustness of border-ownership neuron firing. We construct an example hierarchical neural network that includes feedforward excitation and lateral inhibition to enhance border-ownership assignment.

9:30AM *A Bio-Inspired Approach Modeling Spiking Neural Networks of Visual Cortex for Human Action Recognition [#N-14725]*

Haihua Liu and Na Shu, South-central University for Nationalities, China

Human visual system is an effective recognition one. Based on information processing mechanism of visual cortex, a bio-inspired approach for the human action recognition from video sequences is proposed in this paper. The approach gives a hierarchical architecture of the feedforward spiking neural network modeling two visual cortical areas: primary visual cortex (V1) and middle temporal area (MT), neurobiologically dedicated to motion processing. We augment the operator of motion information processing with center surround interaction to model the nonclassical receptive field inhibitory effect based on horizontal connection of spiking neurons in each cortical area. The weight function of lateral connection between V1 and MT areas is built based on a previous study that explained direction selectivity in MT area by a linear combination of normalized V1 direction-tuned signals. Moreover, we propose a three-dimensional (3D) Gabor filter to model the spatiotemporal direction and speed tuning properties of time-dependent receptive fields of the V1 cells. The conductance-driven integrate-and-fire (IF) neuron model is used to obtain spike trains generated by the spiking neurons in two cortical areas. Finally, in order to analyze spike trains, we consider a characteristic of the neural code: mean motion map based on the mean firing rates of neurons in MT, called action code, as feature vector representing human actions. The approach is carried out on the Weizmann and KTH action database. Experimental results show that our approach has higher recognition performance and computational efficiency than other bio-inspired ones.

9:50AM *Measurement of Confusion Color Pairs for Dichromats in order to Use Applications Supporting Color Vision Deficiency [#N-14219]*

Hiroki Takagi, Hiroaki Kudo, Tetsuya Matsumoto, Yoshinori Takeuchi and Noboru Ohnishi, Nagoya University, Japan; Daido University, Japan

Recently, various applications of mobile devices supporting color vision deficiency are released. However, applications supporting color vision deficiency may not work as designed performance. Color calibration and personalization are needed when the user uses such an application, because a color representation performance of devices is distinct from each other, and users may also have individual differences in characteristics of color vision. Thus, confusion color pairs will change slightly. Conversely, it will be a clue for color calibration or personalization in oder to reduce changes. Here, we propose methods determining confusion color pairs by a simple operation to achieve it. We estimate color pairs by the procedure as a bisection method in order to determine them. A user is presented with the three visual stimuli (a reference and two targets). The user selects one of test targets whose color is perceived more similar to reference's color. We focused on how to select visual stimuli's colors. We propose two methods to select ones, which are represented the coordinates on u'v'-chromaticity diagram. One method uses colors on a circumference whose center corresponds to the white point. Another method uses colors on parallel lines to the line passing through primary colors (green and blue). We obtained results that it shows comparable performance determining color pairs to previous studies. Results of lines' method show that performance is better than the circumference method. And, its measurement time is reduced.

FrN1-5 Data Analysis and Pattern Recognition

Friday, July 11, 8:10AM-10:10AM, Room: 305D, Chair: Wladyslaw Homenda

8:10AM *View-Invariant Gait Recognition via Deterministic Learning [#N-14230]*

Wei Zeng and Cong Wang, South China University of Technology, China

In this paper, we present a new method to eliminate the effect of view angle for efficient gait recognition via deterministic learning theory. The width of the binarized silhouette model the periodic deformation of human gait silhouettes. It captures the spatio-temporal characteristics of each individual, represents the dynamics of gait motion, and can sensitively reflect the variance between gait patterns across various views. The gait recognition approach consists of two phases: a training phase and a recognition phase. In the training phase, the gait dynamics underlying different individuals' gaits from different view angles are locally accurately approximated by radial basis function (RBF) neural networks. Obtained knowledge of approximated gait dynamics is stored in constant RBF networks. In order to address the problem of view change no matter the variation is small or significantly large, the training patters from different views constitute a uniform training dataset containing all kinds of gait dynamics of each individual observed across various views. In the recognition phase, a bank of dynamical estimators is constructed for all the training gait patterns. Prior knowledge of human gait dynamics represented by the constant RBF networks is embedded in the estimators. By comparing the set of estimators with a test gait pattern whose view pattern contained in the prior training dataset, a set of recognition errors are generated. The average L1 norms of the errors are taken as the similarity measure between the dynamics of the training gait patterns and the test gait pattern. Finally, comprehensive experiments are carried out on the CASIA-B and CMU gait databases to demonstrate the effectiveness of our approach.

8:30AM *Micro-Expression Recognition Based on Local Binary Patterns from Three Orthogonal Planes and Nearest Neighbor Method [#N-14394]*

Yanjun Guo, Yantao Tian, Xu Gao and Xuange Zhang, Jilin University, China

Micro-expression is a very short and rapid involuntary facial expression, which reveals suppressed affect. Recognizing micro-expression can help to accurately grasp the real feelings of people, a result that can have an important practical impact. But the scholars' studies have demonstrated that real micro-expression is difficult to identify. There are two main restrictive factors, one is the need of a comprehensive and typical database, and the other one is the need of a suitable method. This paper proposes a combination of local binary patterns from three orthogonal planes (LBP-TOP) and the nearest neighbor method, and does experiments on a large database. At last, a reasonable result is obtained.

8:50AM *Classification with Rejection Based on Various SVM Techniques [#N-14451]*

Wladyslaw Homenda, Marcin Luckner and Witold Pedrycz, Warsaw University Technology, Poland; Polish Academy of Sciences, Poland

The task of identifying native and foreign elements and rejecting foreign ones in the pattern recognition problem is discussed in this paper. Such the task is a nonstandard aspect of pattern recognition, which is rarely present in research. In this paper, ensembles of support vector machines solving two-classes and one-class problems are employed as classification tools and as basic tools for rejecting of foreign elements. Evaluation of quality of classification and rejection methods are proposed in the paper and finally some experiments are performed in order to illustrate acquainted terms and methods.

9:10AM *Imbalanced Pattern Recognition: Concepts and Evaluations [#N-14650]*

Wladyslaw Homenda and Wojciech Lesinski, Warsaw University Technology, Poland; University of Bialystok, Poland

In this paper we propose and investigate a concept of imbalanced pattern recognition problems and evaluation methods of solutions applied to solve such problems. The attention is focused on so called paper-to-computer technologies, but it is not limited to them due to possible direct generalization to other domains. Besides bringing a concept of imbalanced pattern recognition problem, classification quality from the perspective of single classes is considered. Parameters of binary classification and parameters and measures used in signal detection theory are adopted. Quality of classification in terms of one class contra all others is taken into account. Then, classifiers performance in frames of one class at the background of other classes and in frames of impact of other classes on the given on are evaluated. Finally, parameters characterizing global properties of classification are introduced and illustrated.

9:30AM *RNN and SOM Based Classifier to Recognize Assamese Fricative Sounds Designed Using Frame Based Temporal Feature Sets [#N-14667]*

Chayashree Patgiri, Mousmita Sarma and Kandarpa Kumar Sarma, Gauhati University, India

In this work, Recurrent Neural Network (RNN) is trained using cepstral feature and difference cepstral feature vectors on a frame by frame basis to learn the temporal patterns of fricative sounds or phonemes of Assamese language and a hybrid algorithm is developed to recognize these fricative phonemes from certain words containing those fricatives. To preserve the temporal information of the speech segment, we consider here a frame-based hybrid approach to recognize fricatives from Assamese speech. A hybrid feature set is developed where simple frame-based feature is combined with differential frame-based feature. Investigation of feature extraction techniques like Linear Predictive Cepstral Coefficient (LPCC) and Mel-Frequency Cepstral Coefficient (MFCC) have been carried out and their performances have been evaluated for the recognition of Assamese fricative phonemes. Here, speech segment is divided into 20 millisecond frames with overlap of 10 millisecond to extract features. Also, difference of a current frame with its preceding and succeeding frame is considered for more accurate dynamic approach for fricative recognition. The differential processing enables to reduce correlation and retain only the most relevant portion of the input. After obtaining the feature vectors, to categorize the related features into different classes and remove repeating data, Self Organizing Map (SOM) has been used. Thus the features obtained from the phoneme signal has been reduced into different sized cluster centres provided by SOM. The reduced feature vector has been fed to the RNN based hybrid classifier for learning the pattern and recognizing any unknown fricative segment.

9:50AM *Artificial Neural Network Based Gait Patterns Identification Using Neuromuscular Signals and Soft Tissue Deformation Analysis of Lower Limbs Muscles [#N-14818]*

S. M. N. Arosha Senanayake, Joko Triloka, Owais A, Malik and Muhammad Pg. Iskandar, Universiti Brunei Darussalam, Brunei Darussalam

The objective of this study is to investigate the use of electromyography (EMG) signals and video based soft tissue deformation (STD) analysis for identifying the gait patterns of healthy and injured subjects. The system includes a wireless surface electromyography (EMG) sensor unit and two video camera systems for measuring the neuromuscular activity of lower limb

muscles, and a custom- developed artificial neural network based intelligent system software for identifying the gait patterns of subjects during walking activity. The system uses root mean square (RMS) value of EMG signals and soft tissue deformation parameter (STDP) as the input features. In order to estimate the STD during a muscular contraction while walking, flexible triangular meshes are built on reference points. The positions of these selected points are evaluated by applying the block matching motion estimation technique. Based on the extracted features, multilayer feed-forward backpropagation networks (FFBPNNs) with different network training functions were designed and their classification performances were compared. The system has been tested for a group of healthy and injured subjects. The results showed that FFBPNN with Levenberg-Marquardt training function provided better prediction behavior (98% overall accuracy) as compared to FFBPNN with other training functions for gait patterns identification based on RMS value of EMG and STDP.

FrN1-6 Hybrid Architectures and Learning

Friday, July 11, 8:10AM-10:10AM, Room: 305E, Chair: Gianluca Bontempi

8:10AM *Recursive Soft Margin Subspace Learning [#N-14052]*

Qiao Ye, Zhao Chun and Ye Ning, Nanjing Forestry University, China; Nanjing University of Science and Technology, China

In this paper, we propose a recursive soft margin (RSM) subspace learning framework for dimension reduction of high-dimensional data, which has strong recognition ability. RSM is motivated by the soft margin criterion of support vector machines (SVMs), which allows some training samples to be misclassified for a certain cost to achieve higher recognition results. Instead of maximizing the sum of squares of Euclidean interclass (called intracluster in unsupervised learning) pairwise distances over all the similar points in previous work, RSM seeks to maximize every pairwise interclass distance between two similar points, and this distance is represented in absolute. Then, we introduce a symmetrical Hingle loss function into the RSM framework. Doing so is to allow some pairwise interclass distances to violate the maximization constraint, such that we can get satisfactory classification performance by losing some training performance. To find multiple projection vectors, a recursive procedure is designed. Our framework is illustrated with Graph Embedding (GE). For any dimension reduction method expressible by the GE, it can thus be generalized by the proposed framework to boost their recognition power by reformulating the original problems.

8:30AM *Sub-Classifier Construction for Error Correcting Output Code Using Minimum Weight Perfect Matching [#N-14121]*

Patoomsiri Songsiri, Thimaporn Phetkaew, Ryutaro Ichise and Boonserm Kijsirikul, Chulalongkorn University, Thailand; Walailak University, Thailand; National Institute of Informatics, Japan

Multi-class classification is mandatory for real world problems and one of promising techniques for multi-class classification is Error Correcting Output Code. We propose a method for constructing the Error Correcting Output Code to obtain the suitable combination of positive and negative classes encoded to represent binary classifiers. The minimum weight perfect matching algorithm is applied to find the optimal pairs of subset of classes by using the generalization performance as a weighting criterion. Based on our method, each subset of classes with positive and negative labels is appropriately combined for learning the binary classifiers. Experimental results show that our technique gives significantly higher performance compared to traditional methods including One-Versus-All, the dense random code, and the sparse random code. Moreover, our method requires significantly smaller number of binary classifiers while maintaining accuracy compared to One-Versus-One.

8:50AM *Supervised Topic Regression via Experts [#N-14168]*

Song Lin and Ping Guo, Beijing Institute of Technology, China

This paper focuses on the research issue of supervised topic models. Traditionally, an unsupervised topic model is typically supervised by incorporating a supervised linear operator. Although this kind of methods has successfully achieved supervised topic representations, as well as tractable computational complexity, the main limitation lies in that it assumes the topic data is linearly distributed. Therefore, when the practical data does not follow the linear property, the model cannot perform well. To solve this problem, a non-linear supervised topic model is proposed in this paper. Specifically, the mixture of experts (ME), as a kind of "divide and conquer", is utilized to deal with the regression of non-linear of topic data. We integrate the mixture of experts and unsupervised latent Dirichlet allocation (LDA) in a Bayesian manner. The proposed model can also reduce overfitting problem of ME with inputting high-dimensional data. An elegant learning algorithm is derived based on variational expectation maximization algorithm. Experimental results show that the proposed model has better predictive performances compared with usupervised topic models, and some state-of-the-art supervised topic regression models (including sLDA model and MedLDA model), on two textual datasets and one image dataset.

9:10AM *A Robust Framework for Short Text Categorization Based on Topic Model and Integrated Classifier [#N-14353]*

Peng Wang, Heng Zhang, Yu-Fang Wu, Bo Xu and Hong-Wei Hao, Institute of Automation of the Chinese Academy of Sciences, China

In this paper, we propose a method for short text categorization using topic model and integrated classifier. To enrich the representation of short text, the Latent Dirichlet Allocation (LDA) model is used to extract latent topic information. While for classification, we combine two classifiers for achieving high reliability. Particularly, we train LDA models with variable number of topics using the Wikipedia corpus as external knowledge base, and extend labeled Web snippets by potential topics extracted by LDA. Then, the enriched representation of snippets are used to learn Maximum Entropy (MaxEnt) and support vector machine (SVM) classifiers separately. Finally, viewing that the most possible predicted result will appear in the top two candidates selected by MaxEnt classifier, we develop a novel scheme that if the gap between these candidates is large enough, the predicted result is considered to be reliable; otherwise, the SVM classifier will be integrated with MaxEnt classifier to make a comprehensive prediction. Experimental results show that our framework is effective and can outperform the state-of-the-art techniques.

9:30AM *Linear Subspace Learning via Sparse Dimension Reduction [#N-14154]*

Ming Yin, Yi Guo and Junbin Gao, Guangdong University of Technology, China; CSIRO, Australia; Charles Sturt University, Australia

Linear Subspace Learning (LSL) has been widely used in many areas of information processing, such as dimensionality reduction, data mining, pattern recognition and computer vision. Recent years have witnessed several excellent extensions of PCA in LSL. One is the recent L1-norm maximization principal component analysis (L1Max-PCA), which aims at learning linear subspace efficiently. L1Max-PCA simply simulates PCA by replacing the covariance with the so-called L1-norm dispersion in the mapped feature space. However, it is difficult to give an intuitive interpretation. In this paper, a novel subspace learning approach based on sparse dimension reduction is proposed, which enforces the sparsity of the mapped data to better recover cluster structures. The optimization problem is solved

efficiently via Alternating Direction Method (ADM). Experimental results show that the proposed method is effective in subspace learning.

9:50AM *Learning Optimization for Decision Tree Classification of Non-Categorical Data with Information Gain Impurity Criterion [#N-14740]*
Konstantin Sofeikov, Ivan Tyukin, Alexander Gorban, Eugene Mirkes, Danil Prokhorov and Ilya Romanenko, University of Leicester, United Kingdom; Toyota Technical Centre, Ann Arbor, United States; Apical LTD, Apical Technical Centre, United Kingdom

We consider the problem of construction of decision trees in cases when data is non-categorical and is inherently high-dimensional. Using conventional tree growing algorithms that either rely on univariate splits or employ direct search methods for determining multivariate splitting conditions is computationally prohibitive. On the other hand application of standard optimization methods for finding locally optimal splitting conditions is obstructed by abundance of local minima and discontinuities of classical goodness functions such as e.g. information gain or Gini impurity. In order to avoid this limitation a method to generate smoothed replacement for measuring impurity of splits is proposed. This enables to use vast number of efficient optimization techniques for finding locally optimal splits and, at the same time, decreases the number of local minima. The approach is illustrated with examples.

Friday, July 11, 10:30AM-12:30PM

Special Session: FrN2-1 Computational Intelligence Algorithms for Digital Audio Applications

Friday, July 11, 10:30AM-12:30PM, Room: 308, Chair: Stefano Squartini and Francesco Piazza

10:30AM *Semi-Supervised Non-Negative Tensor Factorisation of Modulation Spectrograms for Monaural Speech Separation [#N-14257]*
Tom Barker and Tuomas Virtanen, Tampere University of Technology, Finland

This paper details the use of a semi-supervised approach to audio source separation. Where only a single source model is available, the model for an unknown source must be estimated. A mixture signal is separated through factorisation of a feature-tensor representation, based on the modulation spectrogram. Harmonically related components tend to modulate in a similar fashion, and this redundancy of patterns can be isolated. This feature representation requires fewer parameters than spectrally based methods and so minimises overfitting. Following the tensor factorisation, the separated signals are reconstructed by learning appropriate Wiener-filter spectral parameters which have been constrained by activation parameters learned in the first stage. Strong results were obtained for two-speaker mixtures where source separation performance exceeded those used as benchmarks. Specifically, the proposed semi-supervised method outperformed both semi-supervised non-negative matrix factorisation and blind non-negative modulation spectrum tensor factorisation.

10:50AM *Power Normalized Cepstral Coefficients Based Supervectors and i-Vectors for Small Vocabulary Speech Recognition [#N-14300]*
Emanuele Principi, Stefano Squartini and Francesco Piazza, Universita' Politecnica delle Marche, Italy

Template-matching and discriminative techniques, like support vector machines (SVMs), have been widely used for automatic speech recognition. Both methods require that varying length sequences are mapped to vectors of fixed lengths: in template-matching, the problem is solved by means of dynamic time warping (DTW), while in SVM with dynamic kernels. The supervector and i- vector paradigms seem to represent a valid solution to such a problem when SVM are employed for classification. In this work, Gaussian mean supervectors (GMS), Gaussian posterior probability supervectors (GPPS) and i-vectors are evaluated as features both for template-matching and for SVM-based speech recognition in a comparative fashion. All these features are based on Power Normalized Cepstral Coefficients (PNCCs) directly extracted from speech utterances. The different methods are assessed in small vocabulary speech recognition tasks using two distinct corpora, and they have been compared to DTW, dynamic time alignment kernel (DTAK), outerproduct of trajectory matrix, and PocketSphinx as further recognition techniques to be evaluated. Experimental results showed the appropriateness of the supervector and i- vector based solutions with respect to the other state-of-the art techniques here addressed.

11:10AM *Advanced Audio Spatializer Combined with a Multipoint Equalization System [#N-14303]*
Stefania Cecchi, Andrea Primavera, Francesco Piazza, Ferruccio Bettarelli and Junfeng Li, Universita' Politecnica delle Marche, Italy; Leaff Engineering, Italy; Institute of Acoustics, Chinese Academy of Sciences, China

The paper deals with the development of a real time system for the reproduction of an immersive audio field considering the crosstalk cancellation and the room response equalization issues. In particular, the real-time system is composed of two parts: a crosstalk cancellation network and a combined multipoint equalization structure. The former is required in order to have a spatialized audio and it is based on the free-field relationship in order to not introduce a timbre alteration. The latter is used to improve the objective and subjective quality of sound reproduction systems by compensating the room and loudspeakers transfer function. Both steps are based on a-priori analysis of the real environment using real impulse responses measured in different positions. In particular, an offline procedure capable of determining the tuning parameters for the crosstalk network and of deriving the final filters for the equalization structure, is adopted. Several results are presented in order to show the effectiveness of the proposed algorithms considering objective and subjective evaluations and comparing the presented approach with the state of the art.

11:30AM *Advanced Intelligent Acoustic Interfaces for Multichannel Audio Reproduction [#N-14364]*
Danilo Comminiello, Stefania Cecchi, Michele Gasparini, Michele Scarpiniti, Aurelio Uncini and Francesco Piazza, Sapienza University of Rome, Italy; Universita' Politecnica delle Marche, Italy

Nowadays, there is a large interest towards multimedia audio systems as a consequence of the development of advanced digital signal processing techniques. In particular, immersive speech communication system has gaining increasing attention since they allow to reproduce realistic acoustic image, and thus achieving good performance in terms of sound quality and accuracy. In this scenario a fundamental role is played by intelligent acoustic interfaces which aim at acquiring audio information, processing it, and returning the processed information to the audio rendering system. In this paper, an effective intelligent acoustic interface composed of a microphone array and a signal processing system capable to enhance the intelligibility of the desired information of the transmitting room is proposed, combined with an advanced reproduction system based on an efficient application of a wave field synthesis technique capable to reproduce an immersive scenario in the

receiving room. The whole system has been assessed within a speech communication application involving a moving desired source in a real scenario: objective and subjective evaluation has been reported in order to show the overall system performance.

11:50AM *Audio Onset Detection: A Wavelet Packet Based Approach with Recurrent Neural Networks [#N-14474]*

Erik Marchi, Giacomo Ferroni, Florian Eyben, Stefano Squartini and Bjorn Schuller, Technische Universitaet Muenchen, Germany; Universita Politecnica delle Marche, Italy

This paper concerns the exploitation of multi-resolution time-frequency features via Wavelet Packet Transform to improve audio onset detection. In our approach, Wavelet Packet Energy Coefficients (WPEC) and Auditory Spectral Features (ASF) are processed by Bidirectional Long Short- Term Memory (BLSTM) recurrent neural network that yields the onsets location. The combination of the two feature sets, together with the BLSTM based detector, form an advanced energy-based approach that takes advantage from the multi-resolution analysis given by the wavelet decomposition of the audio input signal. The neural network is trained with a large database of onset data covering various genres and onset types. Due to its data- driven nature, our approach does not require the onset detection method and its parameters to be tuned to a particular type of music. We show a comparison with other types and sizes of recurrent neural networks and we compare results with state-of-the-art methods on the whole onset dataset. We conclude that our approach significantly increase performance in terms of F -measure without any music genres or onset type constraints.

12:10PM *Transfer Learning Emotion Manifestation Across Music and Speech [#N-14702]*

Eduardo Coutinho, Jun Deng and Bjorn Schuller, Technische Universitat Munchen, Germany

In this article, we focus on time-continuous predictions of emotion in music and speech, and the transfer of learning from one domain to the other. First, we compare the use of Recurrent Neural Networks (RNN) with standard hidden units (Simple Recurrent Network - SRN) and Long-Short Term Memory (LSTM) blocks for intra-domain acoustic emotion recognition. We show that LSTM networks outperform SRN, and we explain, in average, 74%/59% (music) and 42%/29% (speech) of the variance in Arousal/Valence. Next, we evaluate whether cross-domain predictions of emotion are a viable option for acoustic emotion recognition, and we test the use of Transfer Learning (TL) for feature space adaptation. In average, our models are able to explain 70%/43% (music) and 28%/11% (speech) of the variance in Arousal/Valence. Overall, results indicate a good cross-domain generalization performance, particularly for the model trained on speech and tested on music without pre-encoding of the input features. To our best knowledge, this is the first demonstration of cross-modal time-continuous predictions of emotion in the acoustic domain.

12:30PM *A Novel Intelligent Systems for Speech Recognition [#N-14727]*

Washington Silva and Ginalber Serra, IFMA, Brazil

The concept of fuzzy sets and fuzzy logic is widely used to propose of several methods applied to systems modeling, classification and pattern recognition problem. This paper proposes a genetic-fuzzy recognition system for speech recognition. In addition to pre-processing, with mel-cepstral coefficients, the Discrete Cosine Transform (DCT) is used to generate a two-dimensional time matrix for each pattern to be recognized. A genetic algorithms is used to optimize a Mamdani fuzzy inference system in order to obtain the best model for final recognition. The speech recognition system used in this paper was named Intelligent Methodology for Speech Recognition(IMSR). Experimental results for speech recognition applied to brazilian language show the efficiency of the proposed methodology compared to methodologies widely used and cited in the literature.

Special Session: FrN2-2 Intelligent Computing for Complex & Big Data Analysis in Health and Biomedical Informatics

Friday, July 11, 10:30AM-12:30PM, Room: 305A, Chair: Amit Kumar and Shang-Ming Zhou

10:30AM *Domain Transfer Nonnegative Matrix Factorization [#N-14110]*

Jim Jing-Yan Wang, Yijun Sun and Halima Bensmail, University at Buffalo, The State University of New York, United States; Qatar Computing Research Institute, Qatar

Domain transfer learning aims to learn an effective classifier for a target domain, where only a few labeled samples are available, with the help of many labeled samples from a source domain. The source and target domain samples usually share the same features and class label space, but have significantly different In these experiments error of the classifier distributions. Nonnegative Matrix Factorization (NMF) has been studied and applied widely as a powerful data representation method. However, NMF is limited to single domain learning problem. It can not be directly used in domain transfer learning problem due to the significant differences between the distributions of the source and target domains. In this paper, we extend the NMF method to domain transfer learning problem. The Maximum Mean Discrepancy (MMD) criteria is employed to reduce the mismatch of source and target domain distributions in the coding vector space. Moreover, we also learn a classifier in the coding vector space to directly utilize the class labels from both the two domains. We construct an unified objective function for the learning of both NMF parameters and classifier parameters, which is optimized alternately in an iterative algorithm. The proposed algorithm is evaluated on two challenging domain transfer tasks, and the encouraging experimental results show its advantage over state-of-the-art domain transfer learning algorithms.

10:50AM *Identifying Stable Breast Cancer Subgroups Using Semi-Supervised Fuzzy c-Means on a Reduced Panel of Biomarkers [#N-14122]*

Daphne Teck Ching Lai and Jonathan Garibaldi, University of Nottingham, United Kingdom

The aim of this work is to identify clinically-useful and stable breast cancer subgroups using a reduced panel of biomarkers. First, we investigate the stability of subgroups generated using two different reduced panels of biomarkers on clustering of breast cancer data. The stability of the subgroups found are assessed based on comparison of agreement levels using Cohen's Kappa Index on clustering solutions from ssFCM methodologies, consensus K-means and model- based clustering. The clustering solutions obtained from the feature set which achieve the higher agreement is chosen for further biological and clinical evaluation to establish the subgroups are clinically-useful. Using a ssFCM methodology, we identified seven clinically-useful and stable breast cancer subgroups using a reduced panel by Soria et al. So far, the stability of the subgroups identified using the reduced panel of biomarkers have not yet been investigated.

11:10AM *Mining Textual Data from Primary Healthcare Records - Automatic Identification of Patient Phenotype Cohorts [#N-14210]*

Shang-Ming Zhou, Muhammad Rahman, Mark Atkinson and Sinead Brophy, Swansea University, United Kingdom

Due to advances of the "omics" technologies, rich sources of clinical, biomedical, contextual, and environmental data about each patient have been available in medical and health sciences. However, an enormous amount of electronic health records is actually generated as textual data, such as descriptive terms/concepts. No doubt, efficiently harnessing these valuable textual data would allow doctors and nurses to identify the most appropriate treatments and the predicted outcomes for a given patient in real time. In this paper, we used textual data to identify patient phenotypes from UK primary care records that were managed by Read codes (a clinical classification system). The fine granularity level of Read codes leads to a huge number of clinical terms to be handled. Unfortunately, traditional medical statistics methods have struggled to process this sort of data effectively. This paper described how the problem of patient phenotype identification can be transformed into document classification task, a text mining scheme is addressed to integrate feature ranking methods and genetic algorithm to identify the most parsimonious subset of features that still holds the capacity of characterizing the distinction of patient phenotypes. The experimental results have demonstrated that compact feature sets with 2 or 3 important terms describing clinical events were effectively identified from 16852 Read codes while their classification accuracy remained high level of agreements with specialists from secondary care in classifying testing samples.

11:30AM *Using EEG Artifacts for BCI Applications [#N-14212]*

Wanli Ma, Dat Tran, Tien Pham, Trung Le and Hong Lin, University of Canberra, Australia; The HCMc University of Pedagogy, Viet Nam; University of Houston-Downtown, United States

Brain computer interface (BCI) is about the communication channel between the brain of a human subject and a computerized device. It was originally conceived to be used by people with disabilities. It can now also be used by people without disabilities as an extra means of communication. Electroencephalography (EEG) signals are the primary choice as the sources of interpreting the intention of the human subject. EEG signals have a long history of being used in human health for the purposes of studying brain activities and medical diagnosis. EEG signals are very weak and are subject to the contamination from many artifact signals. For the applications in human health, true EEG signals, without the contamination, is highly desirable. However, for the purposes of BCI, where stable patterns from the source signals are critical, the origins of the signals are of less concern. In this paper, we propose a BCI, which is simple to implement and easy to use, by taking the advantage of EEG artifacts, generated by a number of purposely designed voluntary facial muscle movements.

11:50AM *Comparison of Distance Metrics for Hierarchical Data in Medical Databases [#N-14302]*

Diman Hassan, Uwe Aickelin and Christian Wagner, University of Nottingham, United Kingdom

Distance metrics are broadly used in different research areas and applications, such as bio-informatics, data mining and many other fields. However, there are some metrics, like pq-gram and Edit Distance used specifically for data with a hierarchical structure. Other metrics used for non-hierarchical data are the geometric and Hamming metrics. We have applied these metrics to The Health Improvement Network (THIN) database which has some hierarchical data. The THIN data has to be converted into a tree-like structure for the first group of metrics. For the second group of metrics, the data are converted into a frequency table or matrix, then for all metrics, all distances are found and normalised. Based on this particular data set, our research question: which of these metrics is useful for THIN data?. This paper compares the metrics, particularly the pq-gram metric on finding the similarities of patients' data. It also investigates the similar patients who have the same close distances as well as the metrics suitability for clustering the whole patient population. Our results show that the two groups of metrics perform differently as they represent different structures of the data. Nevertheless, all the metrics could represent some similar data of patients as well as discriminate sufficiently well in clustering the patient population using k-means clustering algorithm.

12:10PM *Investigating the Impacts of Epilepsy on EEG-Based Person Identification Systems [#N-14316]*

Dinh Phung, Dat Tran, Wanli Ma, Phuoc Nguyen and Tien Pham, University of Canberra, Australia

Person identification using electroencephalogram (EEG) as biometric has been widely used since it is capable of achieving high identification rate. Epilepsy is one of the brain disorders that involves in the EEG signal and hence it may have impact on EEG-based person identification systems. However, this issue has not been investigated. In this paper, we perform person identification on two groups of subjects, normal and epileptic to investigate the impact of epilepsy on the identification rate. Autoregressive model (AR) and Approximate entropy (ApEn) are employed to extract features from these two groups. Experimental results show that epilepsy actually have impacts depending on feature extraction method used in the system.

Special Session: FrN2-3 Data-Driven Adaptive Dynamic Programming

Friday, July 11, 10:30AM-12:30PM, Room: 305B, Chair: Derong Liu and Haibo He

10:30AM *Online Learning Control Based on Projected Gradient Temporal Difference and Advanced Heuristic Dynamic Programming [#N-14606]*

Jian Fu, Haibo He, Aihong Tang and Sujuan Wei, Wuhan University of Technology, China; University of Rhode Island, United States

We present a novel online learning control algorithm (OLCPA) which comprises projected gradient temporal difference for action-value function (PGTDAVF) and advanced heuristic dynamic programming with one step delay (AHDPOSD). PGTDAVF can guarantee the convergence of temporal difference(TD)-based policy learning with smooth action-value function approximators, such as neural networks. Meanwhile, AHDPOSD is a specially designed framework for embedding PGTDAVF in to conduct online learning control. It not only coincides with the intention of temporal difference but also enables PGTDAVF to be effective under nonidentical policy environment, which results in more practicality. In this way, the proposed algorithms achieve the stability and practicability simultaneously. Finally, simulation of online learning control on a cart pole benchmark demonstrates practical control capability and efficiency of the presented method.

10:50AM *A Kalman Filter-Based Actor-Critic Learning Approach [#N-14263]*

Bin Wang and Dongbin Zhao, Institute of Automation, Chinese Academy of Sciences, China

Kalman filter is an efficient way to estimate the parameters of the value function in reinforcement learning. In order to solve Markov Decision Process (MDP) problems in both continuous state and action space, a new online reinforcement learning algorithm using Kalman filter technique, which is called Kalman filter- based actor-critic (KAC) learning is proposed in this paper. To implement the KAC algorithm, Cerebellar Model Articulation Controller (CMAC) neural networks are used to approximate the value function and the policy function respectively. Kalman filter is used to estimate the weights of the critic network. Two benchmark problems, namely the cart-pole balancing problem and the acrobot swing-up problem are provided to verify the effectiveness of the KAC approach. Experimental results demonstrate that the proposed KAC algorithm is more efficient that other similar algorithms.

11:10AM *Self-Learning PD Algorithms Based on Approximate Dynamic Programming for Robot Motion Planning [#N-14529]*

Huiyuan Yang, Qi Guo, Xin Xu and Chuanqiang Lian, National University of Defense Technology, China

Motion planning is a key technology of the navigation and control for mobile robots. However, when considering the complexity of exterior environments and mobile robot's kinematics and dynamics, the motion planning results obtained by some traditional methods are often hard to realize optimization. In this paper, we propose two self-learning PD algorithms to solve motion planning for mobile robots. We firstly utilize a virtual Proportional Derivative (PD) control strategy to transform the motion planning problem into an optimization problem of the virtual control policy. And then two approximate dynamic programming algorithms, which are the Least Squares Policy Iteration (LSPI) algorithm and the Dual Heuristic Programming (DHP) algorithm, are incorporated into the virtual control strategy to tune the PD parameters automatically, namely the LSPI-PD algorithm and the DHP-PD algorithm. Simulations have been performed to validate the effectiveness of the two algorithms and the comparisons illustrate that based on the motion planning results obtained by the LSPI-PD and DHP-PD algorithms, the mobile robot can track the reference path with less tracking error than that by using PD control strategy with fixed parameters. Attribute to the feature of the LSPI and DHP algorithms, the proposed LSPI-PD algorithm is suitable for solving problems with discrete action spaces while the DHP-PD algorithm has an advantage in solving problems with continuous action spaces.

11:30AM *Near Optimal Event-Based Control of Nonlinear Discrete Time Systems in Affine Form with Measured Input Output Data [#N-14534]*

Avimanyu Sahoo, Hao Xu and Sarangapani Jagannathan, Missouri University of Science and Technology, United States

In this paper, an event-based near optimal control of uncertain nonlinear discrete time systems is presented by using input-output data and approximate dynamic programming (ADP). The nonlinear system dynamics in affine form are transformed into an input-output form. Then, three neural networks (NN) with event sampled input-output vector are used, namely, the identifier NN to relax the knowledge of the system dynamics, a critic NN to approximate the value function which is the solution to the Hamilton-Jacobi Bellman (HJB) equation, and an actor NN to approximate the optimal control policy, in an online manner without utilizing value or policy iterations. In addition, the NN weights of all the three NNs are tuned only at event-triggered instants leading to a novel non-periodic update rule to reduce computation when compared to traditional NN based scheme. Further, an event-trigger condition to decide the trigger instants is derived. Finally, the Lyapunov technique is used in conjunction with the event-trigger condition to guarantee the uniform ultimate boundedness (UUB) of the closed-loop system. The analytical design is substantiated with numerical results via simulation.

11:50AM *Event-Triggered Reinforcement Learning Approach for Unknown Nonlinear Continuous-Time System [#N-14656]*

Xiangnan Zhong, Zhen Ni, Haibo He, Xin Xu and Dongbin Zhao, University of Rhode Island, United States; National University of Defense Technology, China; Chinese Academy of Sciences, China

This paper provides an adaptive event-triggered method using adaptive dynamic programming (ADP) for the nonlinear continuous-time system. Comparing to the traditional method with fixed sampling period, the event-triggered method samples the state only when an event is triggered and therefore the computational cost is reduced. We demonstrate the theoretical analysis on the stability of the event- triggered method, and integrate it with the ADP approach. The system dynamics are assumed unknown. The corresponding ADP algorithm is given and the neural network techniques are applied to implement this method. The simulation results verify the theoretical analysis and justify the efficiency of the proposed event-triggered technique using the ADP approach.

12:10PM *Longitudinal Control of Hypersonic Vehicles Based on Direct Heuristic Dynamic Programming Using ANFIS [#N-14810]*

Xiong Luo, Yi Chen, Jennie Si and Feng Liu, University of Science and Technology Beijing, China; Arizona State University, United States

Since the launch of the scramjet, recent years have witnessed a growing interest in the study of airbreathing hypersonic vehicles. Due to its strong coupling characteristics, high nonlinearity, and uncertain parameters, the control of hypersonic vehicle becomes a great challenge. To deal with those design issues, we propose an adaptive learning control method based on direct heuristic dynamic programming (direct HDP), which is used to track the angle of attack despite the presence of bounded uncertain parameters. Inspired by the adaptive critic designs, direct HDP is one of the adaptive dynamic programming (ADP) methods, which is a model-free reinforcement learning algorithm using the online learning scheme to solve dynamic control problems in realistic complex environment. In this paper, this direct HDP method is improved by embedding the fuzzy neural network (FNN) in the controller design to enhance its self-learning ability and robustness. Simulation results are provided to demonstrate the effectiveness of our proposed method.

FrN2-4 Data Mining and Knowledge Discovery

Friday, July 11, 10:30AM-12:30PM, Room: 305C, Chair: Paulo Adeodato and Alessandro Sperduti

10:30AM *A Study on Asynchronous System in P300 Speller Based on User's Intention of Input [#N-14485]*

Kohei Kawai, Tomohiro Yoshikawa and Takeshi Furuhashi, Nagoya University, Japan

P300 speller is the communication tool based on Brain Computer Interfaces (BCIs) which allow users to input letters only by thoughts. It uses P300, one of the event-related potential (ERP), as the target feature. In P300 speller, another person starts and closes the system. Therefore, a user cannot switch P300 speller ON/OFF by himself/herself. To solve this problem, an asynchronous P300 speller which can control ON/OFF based on the user's intention of input is needed. In recent years, the intention classification method with additional pre-training has been proposed. In the additional pre-training, the classifier trains non-control state data which is recorded when the user does not input. However, the additional pre-training causes another burden and usage restrictions. In this paper, we propose and study an intention classification method using only training data in which a user input letters and an asynchronous system in P300 speller based on the user's intention of input.

10:50AM *Insights on Prediction of Patients' Response to Anti-HIV Therapies through Machine Learning [#N-14459]*

Rogerio Rosa, Rafael Santos, Adamo Brito and Katia Guimaraes, UFPE, Brazil

We collect data from the HIV Resistance Drug Database and, based on CD4+ and viral load measures, together with RNA sequences of the reverse transcriptase and of the protease of the virus, we design models using

machine learning techniques MultiLayer Perception (MLP), Radial Basis Function (RBF), and Support Vector Machine (SVM), to predict the patients' response to anti-HIV treatment. In this work we applied the SMOTE Algorithm to deal with the enormous difference between the number of case and control samples, which was crucial for the accuracy of the models. Our results show that the SVM model proved more accurate than the other two, with a ROC curve area of 0.9398. We observe that, from 1000 patients, there are 646 samples for which the three methods delivered correct predictions. On the other hand, for 69 patients all three models fail. We analyzed the data for those patients more carefully, and we identified codons and properties that are important for a response/non-response result. Among the codons that our models identified, there are several with strong support from the literature and also a few new ones. Our analysis offers numerous insights that can be very useful to the prediction of patients' response to anti-HIV therapies in the future.

11:10AM *Recognizing Cross-Lingual Textual Entailment with Co-Training Using Similarity and Difference Views [#N-14531]*

Jiang Zhao and Man Lan, East China Normal University, China

Cross-lingual textual entailment is a relatively new problem that detects the entailment relationship between two text fragments written in different languages. Previous work adopted machine learning algorithms and similarity measures as features to address this task. In order to overcome the high cost of human annotation and further improve the recognition performance, we present a novel co- training approach to solve this problem. We first use an off-the-shelf machine translation tool to eliminate the language gap between two texts. Then we measure the similarities and differences between two texts and regard them as sufficient and redundant views. We use those two views to conduct the co-training procedure to perform classification. Besides, a new effective Kullback-Leibler (KL) based criterion is proposed to select the results from all possible iterations. Experiments on cross-lingual datasets provided by SemEval 2013 show that our method significantly outperforms the baseline systems and previous work.

11:30AM *A Novel Algorithm for Mining Behavioral Patterns from Wireless Sensor Networks [#N-14568]*

Md Mamunur Rashid, Iqbal Gondal and Joarder Kamruzzaman, Monash University, Australia

Due to recent advances in wireless sensor networks (WSNs) and their ability to generate huge amount of data in the form of streams, knowledge discovery techniques have received a great deal of attention to extract useful knowledge regarding the underlying network. Traditionally sensor association rules measure occurrence frequency of patterns. However, these rules often generate a huge number of rules, most of which are non-informative or fail to reflect the true correlation among data objects. In this paper, we propose a new type of sensor behavioral pattern called associated sensor patterns that captures association- like co-occurrences and the strong temporal correlations implied by such co- occurrences in the sensor data. We also propose a novel tree structure called as associated sensor pattern tree (ASPT) and a mining algorithm, associated sensor pattern (ASP) which facilitates frequent pattern (FP) growth-based technique to generate all associated sensor patterns from WSN data with only one scan over the sensor database. Extensive performance study shows that our algorithm is very efficient in finding associated sensor patterns than the existing significant algorithms.

11:50AM *Continuous Variables Segmentation and Reordering for Optimal Performance on Binary Classification Tasks [#N-14934]*

Paulo Adeodato, Domingos S. P. Salazar, Lucas S. Gallindo and Abner G. Sa, Centro de Informatica da UFPE and NeuroTech S.A., Brazil; UAEADTec da Universidade Federal Rural de Pernambuco, Brazil; Universidade Federal de Pernambuco, Brazil; Centro de Informatica da UFPE, Brazil

It is common to find continuous input variables with non-monotonic propensity relation with the binary target variable. In other words, when taken as propensity scores, these variables do not generate unimodal Kolmogorov-Smirnov Curves. However, these variables possess highly discriminant information which could be explored by simple classifiers if properly preprocessed. This paper proposes a new method for transforming such variables by detecting local optima on the KS2 curve, segmenting and reordering them to produce a unimodal KS2 on the transformed variable. The algorithm was tested on 4 selected continuous variables from the benchmark problem of Loan Default Prediction Competition and the results showed significant improvement in performance measured by both the AUC_ROC and Max_KS2 metrics for 3 different Artificial Intelligence algorithms, namely Linear Discriminant Analysis, Logistic Regression and MultiLayer Perceptron.

12:10PM *Hybrid Classification with Partial Models [#N-14649]*

Bo Tang, Quan Ding, Haibo He and Steve Kay, University of Rhode Island, United States; University of California, United States

The parametric classifiers trained with the Bayesian rule are usually more accurate than the nonparametric classifiers such as nearest neighbors, neural network and support vector machine, when the class- conditional densities of distribution models are known except for some of their parameters and the training data is abundant. However, the parametric classifiers would perform poorly if these class conditional densities are unknown and the assumed distribution models are inaccurate. In this paper, we propose a hybrid classification method for the data with partially known distribution models where only the distribution models of some classes are known. For this partial models case, the proposed hybrid classifier makes the best use of knowledge of known distribution models with Bayesian interference, while both purely parametric and non-parametric classifiers would lose a specific predicative capacity for classification. Theoretical proofs and experimental results show that the proposed hybrid classifier has much better performance than these purely parametric and non-parametric classifiers for the data with partial models.

FrN2-5 Large Scale, Associative and Self-Organizing Networks

Friday, July 11, 10:30AM-12:30PM, Room: 305D, Chair: Jinde Cao

10:30AM *A Decomposition Method for Large-Scale Sparse Coding in Representation Learning [#N-14061]*

Yifeng Li, Richard Caron and Alioune Ngom, University of British Columbia, Canada; University of Windsor, Canada

In representation learning, sparse representation is a parsimonious principle that a sample can be approximated by a sparse superposition of dictionary atoms. Sparse coding is the core of this technique. Since the dictionary is often redundant, the dictionary size can be very large. Many optimization methods have been proposed in the literature for sparse coding. However, the efficiency of the optimization for a tremendous number of dictionary atoms is still a bottleneck. In this paper, we propose to use decomposition method for large-scale sparse coding models. Our experimental results show that our method is very efficient.

10:50AM *The Stability and Bifurcation Analysis in High Dimensional Neural Networks with Discrete and Distributed Delays [#N-14298]*

Wenying Xu, Jinde Cao and Min Xiao, Southeast University, China; Nanjing University of Posts and Telecommunications, China

This paper studies the stability and Hopf bifurcation in a high-dimension neural network involving the discrete and distributed delays. Such model extends the existing models of neural networks from low-dimension to high-dimension. Therefore, our model is much close to large real neural networks. Here, the delay is chosen as the bifurcation parameter and we obtain the sufficient conditions for the system keeping stable and undergoing the Hopf bifurcation. Moreover, the software package DDE-BIFTOOL is introduced to better display the properties of the system and the effect of gain parameters of the system and delay kernel on the onset of the bifurcation. The simulation results further justify the validity of our theoretical analysis.

11:10AM *Restricted Boltzmann Machine Associative Memory [#N-14327]*

Koki Nagatani and Masafumi Hagiwara, Keio University, Japan

Restricted Boltzmann machine associative memory (RBMAM) is proposed in this paper. RBMAM memorizes patterns using contrastive divergence learning procedure. It recalls by calculating the reconstruction of pattern using conditional probability. In order to examine the performance of the proposed RBMAM, extensive computer simulations have been carried out. As the result, it has shown that the performance of RBMAM is overwhelming compared with the conventional neural network associative memories. For example as for storage capacity, RBMAM can store about from 2 Nhidden to 4 Nhideen patterns, where Nhidden denotes the number of neurons in the hidden layer. Similarly we have obtained superior performance of RBMAM in respect of noise tolerance and pattern complement.

11:30AM *Two-Factor User Authentication with the CogRAM Weightless Neural Net [#N-14518]*

Weng Kin Lai, Beng Ghee Tan, Ming Siong Soo and Imran Khan, Tunku Abdul Rahman University College, Malaysia; IIUM, Malaysia

The application of the Cognitive RAM (CogRAM) weightless neural net in testing a keystroke biometrics user authentication system for a numeric keypad is discussed in this paper. The two-factor user authentication system developed here uses the common password that is complemented with the keystroke patterns of the users. The keystroke pattern is represented by the force applied to constitute a fixed length passkey to compose a complete pattern for the entered password. The system has been designed and developed around an 8 -bit microcontroller, based on the AVR enhanced RISC architecture. The preliminary experimental results showed that the designed system can successfully authenticate the unique and consistent keystroke biometric patterns of the users.

11:50AM *The Learning of Neuro-Fuzzy Approximator with Fuzzy Rough Sets in Case of Missing Features [#N-14760]*

Robert Nowicki, Bartosz Nowak, Janusz Starczewski and Krzysztof Cpalka, Czestochowa University of Technology, Poland

The architecture of neuro-fuzzy systems with fuzzy rough sets originally has been developed to process with imprecise data. In this paper, the adaptation of those systems to the missing features case is presented. However, the main considerations concern with methods of learning which could be applied to such systems for approximation tasks. Various methods for determining values of system parameters have been considered, in particular the gradient learning method. The effectiveness of proposed methods has been confirmed by many simulation experiments, which results have been supplied to this paper.

12:10PM *A Dynamic Forecasting Method for Small Scale Residential Electrical Demand [#N-14106]*

Andrei Marinescu, Ivana Dusparic, Colin Harris, Vinny Cahill and Siobhan Clarke, Trinity College Dublin, Ireland

Small scale electrical demand forecasting is an emerging field motivated by the penetration of renewable energy sources and the growth of microgrids and virtual power plants. These advances pose more complex forecasting challenges compared to the already established large scale forecasting approaches. Current short term load forecasting methods deal with two types of day, normal and anomalous, which are predicted separately. Anomalous days are classified as such ahead of time, based on key calendar events such as public holidays. However, there are some anomalous days which are not always predictable on a day ahead basis. Due to unforeseen events, a seemingly normal day can progress towards an anomalous case causing high errors in prediction. We propose a new dynamic forecasting mechanism that actively monitors residential electrical demand along a forecasted day, and detects anomalous pattern changes from a previously predicted demand of the day. A self-organising map is employed to detect anomalous days as they progress. Once an anomaly is detected, a neural network based prediction system changes its input neurons according to a previously detected and recorded match found in a database of anomalous days, in order to accommodate the anomalous day prediction. Results are based on measured power demands recorded in Ireland from domestic smart-meters between 2009-2011, and focus on small scale residential electrical demands of up to 350 kWh. During anomalous days our dynamic prediction approach achieves forecasting results within 3.63% of the real load, down from the 7.37% obtained by the initial prediction algorithm and the 5.41% achieved by standalone re-prediction, without pattern matching.

FrN2-6 Self-Organizing Maps

Friday, July 11, 10:30AM-12:30PM, Room: 305E, Chair: Thomas Vacek

10:30AM *A Spiking-Based Mechanism for Self-Organizing RBF Neural Networks [#N-14170]*

Honggui Han, Lidan Wang, Junfei Qiao and Gang Feng, Beijing University of Technology, China; City University of Hong Kong, Hong Kong

In this paper, a spiking growing algorithm (SGA) is proposed for optimizing the structure of radial basis function (RBF) neural network. Inspired by the synchronous behavior of spiking neurons, the spiking strength (ss) of the hidden neurons is defined as the criteria of SGA, which investigates a new way to simulate the connections between hidden and output neurons of RBF neural network. This SGA-based RBF (SGA-RBF) neural network can self-organize the hidden neurons online, to achieve the appropriate network efficiency. Meanwhile, to ensure the accuracy of SGA-RBF neural network, the structure- adjusting and parameters-training phases are performed simultaneously. Simulation results demonstrate that the proposed method can obtain a higher precision in comparison with some other existing methods.

10:50AM *Support Vector Machine with SOM-Based Quasi-Linear Kernel for Nonlinear Classification [#N-14448]*

Yuling Lin, Yong Fu and Jinglu Hu, Waseda University, Japan

This paper proposes a self-organizing maps (SOM) based kernel composition method for the quasi-linear support vector machine (SVM). The quasi-linear SVM is SVM model with quasi-linear kernel, in which the nonlinear separation

hyperplane is approximated by multiple local linear models with interpolation. The basic idea underlying the proposed method is to use clustering and projection properties of SOM to partition the input space and construct a SOM based quasi-linear kernel. By effectively extracting the distribution information using SOM, the quasi- linear SVM with the SOM-based quasi-linear kernel is expected to have better performance in the cases of high-noise and high-dimension. Experiment results on synthetic datasets and real world datasets show the effectiveness of the proposed method.

11:10AM *The Generative Adaptive Subspace Self-Organizing Map [#N-14673]*

Thusitha Chandrapala and Bertram Shi, HKUST, Hong Kong

The Adaptive Subspace Self Organized Map (ASSOM) is a model that incorporates sparsity, nonlinear pooling, topological organization and temporal continuity to learn invariant feature detectors, each corresponding to one node of the network. Temporal continuity is implemented by grouping inputs into "training episodes". Each episode contains samples from one invariance class and is mapped to a particular node during training. However, this explicit grouping makes application of this algorithm for natural image sequences difficult, since the grouping is generally not known a priori. This work proposes a probabilistic generative model of the ASSOM that addresses this problem. Each node of the ASSOM generates input vectors from one invariance class. Training sequences are generated by nodes that are chosen according to a Markov process. We demonstrate that this model can learn invariant feature detectors similar to those found in the primary visual cortex from an unlabeled sequence of input images generated by a realistic model of eye movements. Performance is comparable to the original ASSOM algorithm, but without the need for explicit grouping into training episodes.

11:30AM *Clustering of the Self-Organizing Map Using Particle Swarm Optimization and Validity Indices [#N-14916]*

Leonardo Enzo Brito da Silva and Jose Alfredo Ferreira Costa, Universidade Federal do Rio Grande do Norte, Brazil

In this paper, an automatic clustering algorithm applied to self-organizing map (SOM) neurons is presented. The connections of the SOM grid are pruned according to a weighted sum of a set of measures of connection strength between adjacent neurons. The coefficients of the weighted sum are obtained through particle swarm optimization (PSO) search in the multidimensional problem space, where the fitness function is the composed density between and within clusters (CDbw) validity index of strongly connected groups of neurons, while scanning through different values of the minimum cluster size so as to find stable regions with a reasonable trade-off between their length and their mean CDbw value. Simulation results are further presented to show the performance of the proposed method applied to synthetic and real world datasets.

Friday, July 11, 1:30PM-3:30PM

Special Session: FrN3-1 Intelligent Adaptive Fault Tolerant Control and Optimization

Friday, July 11, 1:30PM-3:30PM, Room: 308, Chair: Huaguang Zhang and Haibo He

1:30PM *Model-Free Adaptive Dynamic Programming for Online Optimal Solution of the Unknown Nonlinear Zero-Sum Differential Game [#N-14034]*

Chunbin Qin, Huaguang Zhang and Yanhong Luo, Henan University, China; Northeastern University, China

It is well known that the two-player zero-sum differential game problem of the continuous-time nonlinear system relies on the solution of the Hamilton-Jacobi-Isaacs equation, which is a nonlinear partial differential equation that is difficult or impossible to solve. In this paper, a new model-free adaptive dynamic programming algorithm is developed for solving online the Hamilton-Jacobi-Isaacs equation for continuous-time nonlinear system with the fully unknown knowledge of the system dynamics. First, a simultaneous policy iteration algorithm will be given, which can solve the Hamilton-Jacobi-Isaacs equation in an off-line sense, in which the fully knowledge of the system dynamics is required. Second, based on the simultaneous policy iteration algorithm, a new model-free adaptive dynamic programming algorithm is developed for solving online the Hamilton-Jacobi-Isaacs equation, in which the fully knowledge of the system dynamics is not required. Finally, a numerical example is given to demonstrate the convergence and effectiveness of the proposed scheme.

1:50PM *Direct Adaptive Control of a Four-Rotor Helicopter Using Disturbance Observer [#N-14075]*

Fuyang Chen, Bin Jiang and Feifei Lu, Nanjing University of Aeronautics and Astronautics, China

In this paper, a stable multivariable model reference adaptive control (MRAC) scheme is proposed for a four-rotor helicopter with unknown external disturbance. Firstly, the disturbance observer is designed to well monitor the unknown disturbance. And then, the adaptive controller is developed based on the disturbance observer to compensate the external disturbance and track the desired system states. Finally, the simulation results illustrate the effectiveness of the proposed adaptive control scheme.

2:10PM *Discrete-Time Polynomial Fuzzy Observer Designs via a Sum of Squares Approach [#N-14086]*

Yingying Wang, Huaguang Zhang, Jianyu Zhang and Yingchun Wang, Northeastern University, China; Northeastern University and Liaoning Guidaojiaotong Polytechnic Institute, China

In this paper, a sum of squares(SOS) method is proposed to design observers for discrete-time polynomial fuzzy systems. To begin with, a polynomial fuzzy system is proposed to describe the discrete-time nonlinear system. Next, the polynomial fuzzy observers are obtained to estimate the states of the polynomial system, and the SOS conditions are derived. An example is given to show the effectiveness, which also demonstrate the SOS approaches are more relaxed than the existing LMI approaches. Finally, a conclusion is given to complete the paper.

2:30PM *Adaptive Fault-Tolerant Control for a Class of Uncertain Nonlinear MISO Discrete-Time Systems in Triangular Forms with Actuator Failures [#N-14271]*

Lei Liu and Zhanshan Wang, Northeastern University, China

This paper investigates the adaptive actuator failure compensation control for a class of uncertain multi input single out (MISO) discrete time systems with triangular forms. The systems contain the actuator faults of both loss of effectiveness and lock-in-place. With the help of radial basis function neural networks (RBFNN) to approximate the unknown nonlinear functions, an adaptive RBFNN fault-tolerant control (FTC) scheme is designed. Compared with some exist result in which solving linear matrix inequality (LMI) is required, we introduce the backstepping technique to achieve the FTC task. It is proved that the proposed control approach can guarantee that all the signals of the closed- loop system are bounded and that the output can successfully track a reference signal in the presence of the actuator failures. Finally, simulation results are provided to confirm the effectiveness of the control approach.

2:50PM *Decoupling Control for Five-Phase Fault-Tolerant Permanent-Magnet Motor by Using SVM Inverse System Method [#N-14332]*

Guohai Liu, Li Qu, Hao Zhang and Yan Jiang, Jiangsu University, China

This paper presents a new decoupling control of five-phase fault-tolerant permanent-magnet (FTPM) motor drives, based on support vector machine (SVM) and the inverse system theory. The inverse system is constructed to compensate the original system into a pseudo-linear system. SVM is utilized to obtain the inverse system without knowledge of accurate motor model. The complete FTPM motor drive is simulated in Matlab/Simulink environment. The results verify the performance of the proposed method. By using the SVM inverse system, the d-axis current and speed of five-phase FTPM motor system are successfully decoupled. Additionally, the SVM inverse system offers fast speed response and high control accuracy.

3:10PM *Fault Diagnosis of Five-Phase Fault-Tolerant Permanent-Magnet Motor Based on Principal Component Neural Network [#N-14495]*

Guohai Liu and Lu Zhou, Jiangsu University, China

In this paper, a new fault diagnosis method for a five-phase fault-tolerant permanent-magnet (FTPM) motor by using a compact method is proposed. The key is to create a neural network based on principle component analysis (PCA). For a current signal of a five-phase FTPM motor system, PCA theory is used to extract the main element from the fault sample data. It realizes optimum compressed of fault sample data and simplifies structure of neural network in fault diagnosis. Speed and precision of the fault classification are enhanced. The obtained results verify the effectiveness of the proposed method.

Special Session: FrN3-2 Cognitive Computing and Neuro-Cognitive Robots

Friday, July 11, 1:30PM-3:30PM, Room: 305A, Chair: Huajin Tang and Gang Pan

1:30PM *Bio-Inspired Categorization Using Event-Driven Feature Extraction and Spike-Based Learning [#N-14285]*

Bo Zhao, Shoushun Chen and Huajin Tang, Institute for Infocomm Research, Singapore; Nanyang Technological University, Singapore

This paper presents a fully event-driven feedforward architecture that accounts for rapid categorization. The proposed algorithm processes the address event data generated either from an image or from Address-Event-Representation (AER) temporal contrast vision sensor. Bio-inspired, cortex-like, spike-based features are obtained through event-driven convolution and neural competition. The extracted spike feature patterns are then classified by a network of leaky integrate-and-fire (LIF) spiking neurons, in which the weights are trained using tempotron learning rule. One appealing characteristic of our system is the fully event-driven processing. The input, the features, and the classification are all based on address events (spikes). Experimental results on three datasets have proved the efficacy of the proposed algorithm.

1:50PM *A New Learning Rule for Classification of Spatiotemporal Spike Patterns [#N-14288]*

Qiang Yu, Huajin Tang and Kay Chen Tan, National University of Singapore, Singapore; Institute for Infocomm Research, Singapore

In this paper, we present a new learning rule for classification of spatiotemporal spike patterns. This rule is derived from the common Widrow-Hoff rule, and it can be used for both the association and the classification. Through experimental simulations, it can be seen that this rule can successfully train the neuron to reproduce the desired spikes. In the classification task, the neuron is capable to classify different categories with the learning rule. We have proposed two decision-making schemes which are the absolute confidence and the relative confidence criteria. The classification performance is largely improved by the relative confidence criterion. The performance of this rule on classification of spatiotemporal spike patterns is also investigated and benchmarked by the tempotron rule.

2:10PM *Spatial Filter Adaptation Based on Geodesic-Distance for Motor EEG Classification [#N-14500]*

Xinyang Li, Cuntai Guan, Kai Keng Ang, Haihong Zhang and Sim Heng Ong, National University of Singapore, Singapore; Agency for Science, Technology and Research, Singapore

The non-stationarity inherent across sessions recorded on different days poses a major challenge for practical electroencephalography (EEG)-based Brain Computer Interface (BCI) systems. To address this issue, the computational model trained using the training data needs to adapt to the data from the test sessions. In this paper, we propose a novel approach to compute the variations between labelled training data and a batch of unlabelled test data based on the geodesic-distance of the discriminative subspaces of EEG data on the Grassmann manifold. Subsequently, spatial filters can be updated and features that are invariant against such variations can be obtained using a subset of training data that is closer to the test data. Experimental results show that the proposed adaptation method yielded improvements in classification performance.

2:30PM *Decoding Motor Cortical Activities of Monkey: A Dataset [#N-14736]*

Luoqing Zhou, Yu Qi, Yueming Wang, Gang Pan, Yiwen Wang, Xiaoxiang Zheng and Zhaohui Wu, Zhejiang University, China

Motor brain-machine interface (BMI) has great potentials in neural motor prostheses and has received increasing attention during the past decades in the neural engineering field. It requires an approach to decode neural activities that represents desired movements. Much of the progress in decoding algorithms has been driven by the availability of neural data, e.g. spike trains, in some research groups having animal laboratories and capable of performing surgery and building BMI systems. However, researchers in the neural signal processing field often face a dilemma of lacking neural data. To continue the innovation in decoding algorithms, this paper introduces a public neural dataset, the ZJU Neural Decoding Dataset (ZJUNDD). We give the detailed paradigm of the BMI system on monkey, including the experimental setup and the collection of 96- channel motor cortical activities. The dataset contains spike rates of neurons obtained by a consistent spike sorting method. To improve the data quality and reduce outliers, the spike data are carefully selected according to the quality of hand movements of the monkey. A standard protocol is provided for the assessment of decoding algorithms on the dataset, including the partition of training and testing sets, and the evaluation metrics. We also build an online evaluation system in order to enable a fair comparison between decoding approaches. Further, we benchmark several existing algorithms, which provides a basic performance

of the methods. To the best of our knowledge, this is the first public dataset of spike trains for the decoding research of motor cortical activities.

2:50PM *Programming a VG-RAM Based Neural Network Computer [#N-14799]*

Alberto F. De Souza, Avelino Forechi, Filipe W. Mutz, Mariella Berger, Thiago Oliveira-Santos and Claudine Badue, Universidade Federal do Espirito Santo, Brazil

We propose a Virtual Generalizing Random Access Memory (VG-RAM) Weightless Neural Network (WNN) Computer (V'Ger Computer for short). VG-RAM WNNs are very effective pattern recognition tools, offering fast training (one shot training) and competitive recognition performance, if compared with other current techniques. The V'Ger Computer architecture was inspired on the organization of the human neocortex and is composed of hierarchically organized and recurrently interconnected layers of VG-RAM WNN neurons. One layer is connected to another in a way similar to cortico-cortical feed-forward and feedback connections between functionally adjacent and hierarchically organized areas. We have "programmed" the V'Ger Computer for counting from 0 to 9 three times. Our preliminary experimental results showed that V'Ger is capable of executing this sequence of actions in spite of strong interferences.

3:10PM *High-Fidelity Compression of Electroneurographic Signals from Motor Cortex [#N-14880]*

Rachel Zhang, Gang Pan, Yueming Wang and Zhenfang Hu, Zhejiang University, China

In invasive brain-machine interfaces (BMI), the recorded high-quality neural signals produce a large data volume. This calls for effective compression. In this paper, we focus on extracellular recording of motor cortex. First the characteristics of the signals are studied, one of which is that peaks of DCT coefficients at high frequency may correspond to spike firing patterns. Based on these characteristics, we propose a high-fidelity compression framework for these signals. The DCT coefficients of the signal are divided into two parts according to amplitude, rather than frequency. The Low-Amplitude-Component (LAC) is encoded by a phase called Symbol Encoding, which helps to reduce overall distortion. The High-Amplitude-Component (HAC), containing major information and spikes, is encoded by another phase called Hybrid Encoding. It combines the Huffman encoding and a novel Zero-Length-Encoding. Experiments show that the algorithm achieves a compression ratio of 18% without obvious distortion. Moreover, spikes are reserved more than 92%, outperforming existing work. Our algorithm enables low-cost storage devices to store long-time neural signals.

3:30PM *Cognitive Memory Systems in Consciousness and Memory Model [#N-14935]*

Zhongzhi Shi, Xiaofeng Wang and Xi Yang, Institute of Computing Technology, Chinese Academy of Sciences, China

Memory is a fundamental component in human brain and plays very important roles for all mental processes. The analysis of memory systems through cognitive architectures can be performed at the computational, or functional level, on the basis of empirical data. In this paper we discuss memory systems in the extended Consciousness and Memory Model (CAM) The knowledge representations used in CAM for working memory, semantic memory, episodic memory and procedural memory are introduced. It will be explained how, in CAM, all of these knowledge types are represented in dynamic decription logic (DDL), a formal logic with the capability for description and reasoning regarding dynamic application domains characterized by actions.

FrN3-3 Unsupervised Learning and Clustering

Friday, July 11, 1:30PM-3:30PM, Room: 305B, Chair: Alessandro Ghio

1:30PM *Controlling Orthogonality Constraints for Better NMF Clustering [#N-14035]*

Ievgen Redko and Younes Bennani, Universite Paris 13 - Sorbonne Paris Cite, France

In this paper we study a variation of a Nonnegative Matrix Factorization (NMF) called the Orthogonal NMF(ONMF). This special type of NMF was proposed in order to increase the quality of clustering results of standard NMF by imposing orthogonality on clustering indicator matrix and/or the matrix of basis vectors. We develop an extension of ONMF which we call Weighted ONMF and propose a novel approach for imposing orthogonality on the matrix of basis vectors obtained via NMF using Gram-Schmidt process.

1:50PM *Random Subspaces NMF for Unsupervised Transfer Learning [#N-14037]*

Ievgen Redko and Younes Bennani, Universite Paris 13 - Sorbonne Paris Cite, France

In this paper we propose a new unsupervised transfer learning approach which aims at finding a partition of unlabeled data in target domain using the knowledge obtained from clustering a source domain unlabeled data. The key idea behind our method is that finding partitions in different feature's subspaces of a source task can help to obtain a more accurate partition in a target one. From the set of source partitions we select only k nearest neighbors using some measure of similarity. Finally, multi-layer non-negative matrix factorization is performed to obtain a partition of objects in target domain. Experimental results show high potential and effectiveness of the proposed technique.

2:10PM *User-Generated-Video Summarization Using Sparse Modelling [#N-14336]*

Yulong Liu, Huaping Liu, Yunhui Liu and Fuchun Sun, Tsinghua University, China

A novel key-frame extraction method is proposed in this paper. Our method focused on user-generated-videos which were captured by smartphones or tablets or other smartdevices which can record acceleration values and orientation values during video capturing. Our method use Dissimilarity-based Sparse Modeling Representative Selection(DSMRS) on orientation information to extract key-frames instead of visual features used by traditional key-frame extraction methods. Acceleration value is used in our method to exclude outliers.

2:30PM *Smartphone Battery Saving by Bit-Based Hypothesis Spaces and Local Rademacher Complexities [#N-14191]*

Davide Anguita, Alessandro Ghio, Luca Oneto and Sandro Ridella, University of Genoa, Italy

Smartphones emerge from the incorporation of new services and features into mobile phones, allowing to implement advanced functionalities for the final users. The implementation of Machine Learning (ML) algorithms on the smartphone itself, without resorting to remote computing systems, allow to achieve such goals without expensive data transmission. However, smartphones are resource-limited devices and, as such, suffer from many issues, which are typical of stand-alone devices, such as limited battery capacity and processing power. We show in this paper how to build a thrifty classifier by exploiting bit-based hypothesis spaces and local Rademacher Complexities. The resulting classifier is tested on a real-world Human Activity Recognition application, implemented on a Samsung Galaxy S II smartphone.

2:50PM *SVD Truncation Schemes for Fixed-Size Kernel Models [#N-14691]*

Ricardo Castro, Siamak Mehrkanoon, Anna Marconato, Johan Schoukens and Johan Suykens, KU Leuven, Belgium; Vrije Universiteit Brussel, Belgium

In this paper, two schemes for reducing the effective number of parameters are presented. To do this, different versions of Fixed-Size Kernel models based on Fixed-Size Least Squares Support Vector Machines (FS-LSSVM) are employed. The schemes include Fixed-Size Ordinary Least Squares (FSOLS) and Fixed-Size Ridge Regression (FS-RR) with their respective truncations through Singular Value Decomposition (SVD). When these schemes are applied to the Silverbox and Wiener-Hammerstein data sets in system identification, it was found that a great deal of the complexity of the model could be reduced in a trade-off with the generalization performance.

FrN3-4 Cognition, Bio-Inspired and Biomorphic Systems

Friday, July 11, 1:30PM-3:30PM, Room: 305C, Chair: Ali Minai

1:30PM *The Stapedius Reflex: Processing Its Neuronal Activity with a Small Embedded System [#N-14748]*

Ralf Warmuth and Ralf Salomon, University of Rostock, Germany

Cochlear implants require a first calibration, which is usually done during surgery. This calibration is normally based on the inspection of the stapedius reflex, which is the contraction of a very tiny muscle in the inner ear. Even though being state-of-the-art, this visual inspection is limited and error prone due to various reasons. This paper proposes a small embedded system that automatically processes the action potentials of the stapedius muscle. Among other things, this process also signals the appearance of the stapedius reflex. Since particular emphasis is given on computational demands as low as possible, the developed system may be integrated into future version of the implant's speech processor.

1:50PM *Dynamic Modeling of an Ostraciiform Robotic Fish Based on Angle of Attack Theory [#N-14794]*

Wei Wang, Guangming Xie and Hong Shi, Peking University, China; Beijing Institute of Petrochemical Technology, China

This paper focuses on the dynamic modeling of a self-propelled, multimodal ostraciiform robotic fish, whose three active joints (two pectoral fins and one caudal fin) are actuated by a Central Pattern Generator (CPG) controller. Compared with other dynamic modes for robotic fish, we introduce angle of attack (AoA) theory on the fish modeling, which can be used to further explore the relationship between swimming efficiency and AoA of robotic fish. First, by using the quasisteady wing theory, AoA of the oscillatory fins are explicitly derived. Then, with the simplification of the robot as a multi-rigid-body mechanism, AoA-based fluid forces acting on the oscillatory fins of the robot are further approximately calculated in a three-dimensional context. Next, by importing the driving signals (generated by CPG control law) into a Lagrangian function, the differential-algebraic equations are employed to establish a hydrodynamic model for steady swimming of the ostraciiform robotic fish for the first time. Finally, comparative results between simulations and experiments for forward and turning gaits of the robot are systematically conducted to show the effectiveness of the built AoA-based dynamic model.

2:10PM *Detection of Signaling Pathways in Human Brain during Arousal of Specific Emotion [#N-14886]*

Reshma Kar, Amit Konar, Aruna Chakraborty and Atulya Nagar, Jadavpur University, India; St. Thomas College of Engineering and Technology, India; Liverpool Hope University, United Kingdom

Neuroscientists usually determine similarity between EEG electrode signals, by a measure of pairwise linear dependence among them. However, recent research indicates the drawbacks of analyzing the pairwise dependence of signals instead of analyzing the simultaneous joint interdependence among them. To overcome this problem we propose a novel similarity measure known as probabilistic relative correlation. Our approach is unique because our similarity measure allows the electrodes to have probabilistic similarity measures and recognizes emotion dependent structures even from mismatched sequences of correlation. We further validate our proposed similarity measure by testing it on the well-known emotion recognition problem. Our experiments have noteworthy implications towards realizing the neural signatures of discrete emotions and will allow for the better understanding of neurological pathways associated with different emotional states. To identify the most active neurological pathways in brain during an emotion, we adapt the minimal spanning tree algorithm.

2:30PM *Chunks of Thought: Finding Salient Semantic Structures in Texts [#N-14895]*

Mei Mei, Aashay Vanarase and Ali Minai, University of Cincinnati, United States

As the availability of large, digital text corpora increases, so does the need for automatic methods to analyze them and to extract significant information from them. A number of algorithms have been developed for these applications, with topic modeling-based algorithms such as latent Dirichlet allocation (LDA) enjoying much recent popularity. In this paper, we focus on a specific but important problem in text analysis: Identifying coherent lexical combinations that represent ``chunks of thought'' within the larger discourse. We term these salient semantic chunks (SSCs), and present two complimentary approaches for their extraction. Both these approaches derive from a cognitive rather than purely statistical perspective on the generation of texts. We apply the two algorithms to a corpus of abstracts from IJCNN 2009, and show that both algorithms find meaningful chunks that elucidate the semantic structure of the corpus in complementary ways.

2:50PM *Bio-Inspired Probabilistic Model for Crowd Emotion Detection [#N-14933]*

Mirza Waqar Baig, Emilia Barakova and Matthias Rauterberg, Eindhoven University of Technology, Eindhoven (TU/e), Netherlands

Detection of emotions of a crowd is a new research area, which has never been accounted for research in previous literature. A bio-inspired model for representation of emotional patters in crowd has been demonstrated. Emotions have been defined as evolving patterns as a part of dynamic pattern of events. The model has been developed to detect emotions of a crowd based on knowledge from learned context, psychology and experience of people in crowd management. The emotions of multiple people making a crowd in any surveillance environment are estimated by the sensors signals such a camera and are being tracked and their behavior is modeled using bio-inspired dynamic model. The behavior changes correspond to changes in emotions. Proposed algorithm involves the probabilistic signal processing modelling techniques for analysis of different types of behavior, interaction detection and estimation of emotions. The model has been evaluated using the simulated behavioral model of crowd.

3:10PM *A Self-Organized Artificial Neural Network Architecture that Generates the McGurk Effect [#N-14083]*

Lennart Gustafsson, Tamas Jantvik and Andrew Paplinski, Lulea University of Technology, Sweden; Decuria, Sweden; Monash University, Australia

A neural network architecture, subjected to incongruent stimuli in the form of lip reading of spoken syllables and listening to different spoken syllables, is shown to generate the well-known McGurk effect, e.g. visual /ga/ and auditory /ba/ is perceived as /da/ by the network. The neural network is based on an architecture which has previously been successfully applied to sensory integration of congruent stimuli and is here extended to take into account that lip reading groups consonants into equivalence classes, bilabial, dento-labial and nonlabial consonants, rather than distinguishing between individual consonants.

FrN3-5 Machine Learning and Applications I

Friday, July 11, 1:30PM-3:30PM, Room: 305D, Chair: Bijaya Ketan Panigrahi

1:30PM *Exponential Synchronization for a Class of Networked Linear Parabolic PDE Systems via Boundary Control [#N-14308]*

Jun-Wei Wang, Cheng-Dong Yang and Chang-Yin Sun, University of Science and Technology Beijing, China; Linyi University, China

This paper addresses the problem of exponential synchronization via boundary control for a class of networked linear spatiotemporal dynamical networks consisting of N identical nodes, in which the spatiotemporal behavior of the each node is described by parabolic partial differential equations (PDEs). The purpose of this paper is to design boundary controllers ensuring the exponential synchronization of the networked parabolic PDE system. To do this, Lyapunov's direct method, the vector-valued Wirtinger's inequality, and the technique of integration by parts are employed. A sufficient condition on the existence of the boundary controllers is developed in term of standard of linear matrix inequality (LMI). Finally, numerical simulation results on a numerical example are presented to illustrate the effectiveness of the proposed design method.

1:50PM *Combining Technical Trading Rules Using Parallel Particle Swarm Optimization Based on Hadoop [#N-14366]*

Fei Wang, Philip Yu and David Cheung, The University of Hong Kong, Hong Kong

Technical trading rules have been utilized in the stock markets to make profit for more than a century. However, no single trading rule can ever be expected to predict the stock price trend accurately. In fact, many investors and fund managers make trading decisions by combining a bunch of technical indicators. In this paper, we consider the complex stock trading strategy, called Performance-based Reward Strategy (PRS), proposed by [1]. Instead of combining two classes of technical trading rules, we expand the scope to combine the seven most popular classes of trading rules in financial markets, resulting in a total of 1059 component trading rules. Each component rule is assigned a starting weight and a reward/penalty mechanism based on rules' recent profit is proposed to update their weights over time. To determine the best parameter values of PRS, we employ an improved time variant particle swarm optimization (TVPSO) algorithm with the objective of maximizing the annual net profit generated by PRS. Due to a large number of component rules and swarm size, the optimization time is significant. A parallel PSO based on Hadoop, an open source parallel programming model of MapReduce, is employed to optimize PRS more efficiently. The experimental results show that PRS outperforms all of the component rules in the testing period.

2:10PM *Prediction Interval Estimation for Electricity Price and Demand Using Support Vector Machines [#N-14586]*

Nitin Anand Shrivastava, Abbas Khosravi and Bijaya Ketan Panigrahi, Indian Institute of Technology Delhi, India; Deakin University, Australia

Uncertainty is known to be a concomitant factor of almost all the real world commodities such as oil prices, stock prices, sales and demand of products. As a consequence, forecasting problems are becoming more and more challenging and ridden with uncertainty. Such uncertainties are generally quantified by statistical tools such as prediction intervals (PIs). PIs quantify the uncertainty related to forecasts by estimating the ranges of the targeted quantities. PIs generated by traditional neural network based approaches are limited by high computational burden and impractical assumptions about the distribution of the data. A novel technique for constructing high quality PIs using support vector machines (SVMs) is being proposed in this paper. The proposed technique directly estimates the upper and lower bounds of the PI in a short time and without any assumptions about the data distribution. The SVM parameters are tuned using particle swarm optimization technique by minimization of a modified PI-based objective function. Electricity price and demand data of the Ontario electricity market is used to validate the performance of the proposed technique. Several case studies for different months indicate the superior performance of the proposed method in terms of high quality PI generation and shorter computational time.

2:30PM *Enhancing MOPSO through the Guidance of ANNs [#N-14753]*

Timothy Rawlins, Andrew Lewis, Jan Hettenhausen and Timoleon Kipouros, Griffith University, Australia; Cambridge University, United Kingdom

In existing work, Artificial Neural Networks (ANNs) are often used to model objective functions for Multi-Objective Particle Swarm Optimisation (MOPSO) or MOPSOis used to aid in ANN-training. We instead use an ANN to guide the optimisation algorithm by deciding if a trial solution is worthy of full evaluation. This should be particularly helpful for computationally expensive calculations. We also introduce a level of scepticism to the result produced by the ANN, to account both for inaccuracy in the ANN and the loss of performance in a MOPSO if the reinitialisation of particles is too extreme. As a case study we used a multi-objective optimisation problem that seeks to optimise the shape of an airfoil to minimise drag and maximise lift. We evaluated several different methods for training an ANN: pre-training vs live training, continuous vs single training, and varied initial training set size. For applying the ANN's output to MOPSO we looked at various levels of scepticism and verified ANN quality before applying it. Attainment surfaces were then used to compare the performance of guided and unguided MOPSOs. Our analysis showed the performance of guided MOPSO was significantly better than unguided MOPSO . We further analysed the results to derive guidance for selecting appropriate variations for specific problems.

2:50PM *Training High-Dimensional Neural Networks with Cooperative Particle Swarm Optimiser [#N-14869]*

Anna Rakitianskaia and Andries Engelbrecht, University of Pretoria, South Africa

This paper analyses the behaviour of particle swarm optimisation applied to training high-dimensional neural networks. Despite being an established neural network training algorithm, particle swarm optimisation falls short at training high-dimensional neural networks. Reasons for poor performance of PSO are investigated in this paper, and hidden unit saturation is hypothesised to be a cause of the failure of PSO in training high-dimensional neural networks. An analysis of various activation functions and search space boundaries leads to the conclusion that hidden unit saturation can be slowed down by combining activation function choice with appropriate search space boundaries. Bounded search is shown to significantly outperform unbounded search in high-dimensional neural network error search spaces.

3:10PM *Improved Modeling of Pneumatic Muscle Actuator Using Recurrent Neural Network [#N-14653]*

Alexander Hosovsky, Jana Mizakova and Jan Pitel, Technical University of Kosice, Slovakia

Derivation of models of complex nonlinear systems usually incorporates a number of simplifications in modeled phenomena with the level of these simplifications being dictated primarily by its intended purpose. If the overall model accuracy is insufficient, it might be helpful to use the powerful approximation capabilities of universal approximators like neural networks which are capable of approximating certain types of functions to arbitrary degree of accuracy. On the other hand, using black-box modeling techniques can impair the resulting extrapolation qualities of the model as well as eliminate its physical interpretation. Here an improved dynamic modeling of one-DOF pneumatic muscle actuator using recurrent neural network is proposed. The proposed method preserves the physical meaning of the model while improving its accuracy compared to the original analytic model. System and model responses are compared in closed-loop (using conventional PD controller) and all unmodeled dynamics is treated as disturbance which is identified using Elman neural network. It is shown that the resulting model is applicable for model-based control system design with greater precision.

FrN3-6 Brain-Machine Interfaces

Friday, July 11, 1:30PM-3:30PM, Room: 305E, Chair: Li-Wei Ko

1:30PM *Explorer Based on Brain Computer Interface [#N-14038]*

Lijuan Bai, Tianyou Yu and Yuanqing Li, South China University of Technology, China

In recent years, various applications which apply the hybrid brain computer interface (BCI) have been studied. In this paper, we present a way to operate the explorer with P300 and motor imagery, which is mainly composed of a BCI mouse, a BCI speller and an explorer. Through this system, user can access to my computer and manipulate (open, close, copy, paste, delete) files such as documents, pictures, music, movies and so on. The system has been tested with 5 subjects,and the experimental results show the explorer can be successfully operated according to subjects' intention with only a small number of mistakes.

1:50PM *Multi-Factor EEG-Based User Authentication [#N-14323]*

Tien Pham, Wanli Ma, Dat Tran and Phuoc Nguyen, University of Canberra, Australia

User authentication plays an important role in security systems. In general, there are three types of authentications: password based, token based, and biometrics based. Each has its own merits and drawbacks. Recently, the research communities start to explore the potential of using electroencephalography (EEG) as a new type of user authentication. EEG-based user authentication systems have the combined advantages of both password based and biometric based authentication systems, yet without their drawbacks. In this paper, we propose to take the advantage of rich information, such as age and gender, carried by EEG signals for user authentication in multi-level security systems. Our experiments showed very promising results for the proposed multi-factor EEG-based authentication method.

2:10PM *Recognizing Slow Eye Movement for Driver Fatigue Detection with Machine Learning Approach [#N-14387]*

Yingying Jiao, Bao-Liang Lu, Xiaoping Chen, Shanguang Chen and Chunhui Wang, Shanghai Jiao Tong University, China; China Astronaut Research and Training Center, China

Slow eye movement (SEM) regarded as a sign of onset of sleep is very significant for detecting driver fatigue, but its characteristics and detection algorithm have been rarely involved in the study of driver fatigue detection. In this study, some new features were extracted based on wavelet singularity analysis and statistics to detect SEMs. Six subjects participated in this simulated driving experiment, and for each subject, a more than 2 hours electro-oculogram (EOG) session was recorded. Each session was divided into SEM epochs and non-SEM epochs according to the common judgments made by the two of three experts by the visual recognition criteria of SEMs. Regarding the problem of detecting SEMs as an imbalance classification problem, and through the under-sampling and over- sampling methods a 2s horizontal electro-oculogram (HEO) signal could finally be recognized as the category of SEMs or non-SEMs with the classifiers SVM, GELM, and KNN respectively. Results prove that the proposed features was a little better than the wavelet energy features, and through the combination of the wavelet energy features and the new features based on wavelet singularity analysis and statistics, the classification results were improved obviously.

2:30PM *Neural Signal Analysis by Landmark-Based Spectral Clustering with Estimated Number of Clusters [#N-14481]*

Thanh Nguyen, Abbas Khosravi, Douglas Creighton and Saeid Nahavandi, Deakin University, Australia

Spike sorting plays an important role in analysing electrophysiological data and understanding neural functions. Developing spike sorting methods that are highly accurate and computationally inexpensive is always a challenge in the biomedical engineering practice. This paper proposes an automatic unsupervised spike sorting method using the landmark-based spectral clustering (LSC) method in connection with features extracted by the locality preserving projection (LPP) technique. Gap statistics is employed to evaluate the number of clusters before the LSC can be performed. Experimental results show that LPP spike features are more discriminative than those of

the popular wavelet transformation (WT). Accordingly, the proposed method LPP-LSC demonstrates a significant dominance compared to the existing method that is the combination between WT feature extraction and the superparamagnetic clustering. LPP and LSC are both linear algorithms that help reduce computational burden and thus their combination can be applied into real-time spike analysis.

2:50PM *Calibration-Less Detection of Steady-State Visual Evoked Potentials - Comparisons and Combinations of Methods [#N-14683]*

Hubert Cecotti and Damien Coyle, University of Ulster, United Kingdom

Brain-Computer Interfaces (BCIs) represent a great challenge in signal processing and machine learning, because it is difficult to extract discriminant features corresponding to particular brain responses due to the low signal-to-noise ratio of the EEG signal. Steady-state visual evoked potentials (SSVEPs) are one of the most reliable brain responses to detect in the EEG signal. Although advanced supervised machine learning techniques can improve the classification performance of SSVEP responses, obtaining robust techniques that do not rely on training a classifier is also important. We propose to analyze, compare, and combine the performance of three state-of-the-art techniques for the detection of SSVEP responses across 10 subjects and different time segments to determine if robust classification can be obtained without subject-specific rigorous analysis using a combination of one or more techniques. The methods include two approaches based on spatial filtering, and canonical correlation analysis. The results support the conclusion that the choice of the method does not depend on the time segment, and the current techniques provide equivalent performance.

Friday, July 11, 4:00PM-6:00PM

Special Session: FrN4-1 Computational Intelligence in Cyber Security

Friday, July 11, 4:00PM-6:00PM, Room: 308, Chair: Frank Jiang and Longbing Cao

4:00PM *Cognitive Neural Network for Cybersecurity [#N-14113]*

Leonid Perlovsky and Olexander Shevchenko, Harvard University, United States; OleSoft, United States

This chapter discusses the future of cybersecurity as a warfare between machine learning techniques of attackers and defenders. As attackers will learn to evolve new camouflaging methods for evading better and better defenses, defense techniques will in turn learn new attacker's tricks to defend against. The better technology will win. Here we discuss theory of machine learning based on dynamic logic that are mathematically provable to learn with the fastest possible speed. We also discuss cognitive functions of dynamic logic and related experimental proofs. This new mathematical theory, in addition to being provably fastest machine learning technique, is also an adequate model for several fundamental mechanisms of the mind.

4:20PM *Large Scale Recurrent Neural Network on GPU [#N-14116]*

Boxun Li, Erjin Zhou, Bo Huang, Jiayi Duan, Yu Wang, Ningyi Xu, JIaxing Zhang and Huazhong Yang, Tsinghua University, China; Microsoft Research Asia, China

Large scale artificial neural networks (ANNs) have been widely used in data processing applications. The recurrent neural network (RNN) is a special type of neural network equipped with additional recurrent connections. Such a unique architecture enables the RNN to remember the past processed information and makes it an expressive model for nonlinear sequence processing tasks. However, the large computation complexity makes it difficult to effectively train a recurrent neural network and therefore significantly limits the research on the RNN in the last 20 years. In recent years, the use of graphics processing units (GPUs) becomes a significant advance to speed up the training process of large scale neural networks by taking advantage of the massive parallelism capabilities of GPUs. In this paper, we propose an efficient GPU implementation of the large scale recurrent neural network and demonstrate the power of scaling up the RNN with GPUs. We first explore the potential parallelism of the recurrent neural network and propose a fine-grained two-stage pipeline implementation. Experiment results show that the proposed GPU implementation can achieve 2-11X speed-up compared with the basic CPU implementation with the Intel Math Kernel Library. We then use the proposed GPU implementation to scale up the RNN and improve its performance. The experiment results of the Microsoft Research Sentence Completion Challenge demonstrate that the large scale recurrent network without class layer is able to beat the traditional class- based modest-size recurrent network and achieve an accuracy of 47%, the best result achieved by a single recurrent neural network on the same dataset.

4:40PM *A Connectionist Approach to Airliner Safety [#N-14148]*

Marvin Oliver Schneider and Joao Luis Garcia Rosa, Centro Universitario Senac, Brazil; Universidade de Sao Paulo, Brazil

The present paper introduces the system SINCO-Flightsim, an intelligent hybrid symbolic connectionist approach for the treatment of emergency situations on commercial airliners, currently available as a computer simulation. The system's main focus is on human failure, which accounts for a major part of accidents and incidents in airline traffic. The underlying architecture, using the biologically more plausible learning algorithm GeneRec and contrasting it to learning via back-propagation is presented. System modules are described as well as the learned data sets. In its first version, the system provides a series of typical sensors and means of interaction for treating emergency situations successfully. The respective results are outlined in this paper. We trust that the approach has the potential to contribute to airliner safety as it takes major stress factors off the pilots' shoulders and helps treating emergency situations in a more objective manner.

5:00PM *Attribute Weighting: How and When Does it Work for Bayesian Network Classification [#N-14278]*

Jia Wu, Zhihua Cai, Shirui Pan, Xingquan Zhu and Chengqi Zhang, University of Technology Sydney, Australia; China University of Geosciences Wuhan, China; Florida Atlantic University, United States

A Bayesian Network (BN) is a graphical model which can be used to represent conditional dependency between random variables, such as diseases and symptoms. A Bayesian Network Classifier (BNC) uses BN to characterize the relationships between attributes and the class labels, where a simplified approach is to employ a conditional independence assumption between attributes and the corresponding class labels, i.e., the Naive Bayes (NB) classification model. One major approach to mitigate NB's primary weakness (the conditional independence assumption) is the attribute weighting, and this type of approach has been proved to be effective for NB with simple structure. However, for weighted BNCs involving complex structures, in which attribute weighting is embedded into the model, there is no existing study on whether the weighting will work for complex BNCs and how effective it will impact on the learning of a given task. In this paper, we first survey several complex structure models for BNCs, and then carry out experimental studies to investigate the effectiveness of the attribute weighting

strategies for complex BNCs, with a focus on Hidden Naive Bayes (HNB) and Averaged One-Dependence Estimation (AODE). Our studies use classification accuracy (ACC), area under the ROC curve ranking (AUC), and conditional log likelihood (CLL), as the performance metrics. Experiments and comparisons on 36 benchmark data sets demonstrate that attribute weighting technologies just slightly outperforms unweighted complex BNCs with respect to the ACC and AUC, but significant improvement can be observed using CLL.

5:20PM *Extension of Similarity Measures in VSM: from Orthogonal Coordinate System to Affine Coordinate System [#N-14507]*

Junyu Xuan, Jie Lu, Guangquan Zhang and Xiangfeng Luo, University of Technology, Sydney, Australia; Shanghai University, China

Similarity measures are the foundations of many research areas, e.g. information retrieval, recommender system and machine learning algorithms. Promoted by these application scenarios, a number of similarity measures have been proposed and proposing. In these state-of-the-art measures, vector-based representation is widely accepted based on Vector Space Model (VSM) in which an object is represented as a vector composed of its features. Then, the similarity between two objects is evaluated by the operations on two corresponding vectors, like cosine, extended Jaccard, extended dice and so on. However, there is an assumption that the features are independent with each others. This assumption is apparently unrealistic, and normally, there are relations between features, i.e. the co-occurrence relations between keywords in text mining area. In this paper, a space geometry-based method is proposed to extend the VSM from the orthogonal coordinate system (OVSM) to affine coordinate system (AVSM) and OVSM is proved to be a special case of AVSM. Unit coordinate vectors of AVSM are inferred by the relations between features which are considered as angles between these unit coordinate vectors. At last, five different similarity measures are extended from OVSM to AVSM using unit coordinate vectors of AVSM. Within the numerous application fields of similarity measures, the task of text clustering is selected to be the evaluation criterion. Documents are represented as vectors in OVSM and AVSM, respectively. The clustering results show that AVSM outweighs the OVSM.

Special Session: FrN4-2 Computational Intelligence in Brain Computer Interface

Friday, July 11, 4:00PM-6:00PM, Room: 305A, Chair: Li-Wei Ko and Chin-Teng Lin

4:00PM *Medical Diagnosis Applications Using a Novel Interactively Recurrent Self-Evolving Fuzzy CMAC Model [#N-14236]*

Jyun-Guo Wang, Shen-Chuan Tai and Cheng-Jian Lin, National Cheng Kung University, Taiwan; National Chin-Yi University of Technology, Taiwan

In this paper, a recurrent self-evolving Fuzzy Cerebellar Model Articulation Controller (FCMAC) model for classification problems is developed, namely the interactively recurrent self-evolving fuzzy Cerebellar Model Articulation Controller (IRSFCMAC). The interactively recurrent structure in an IRSFCMAC is formed as external loops and internal feedbacks by feeding the rule firing strength to itself and others rules. The IRSFCMAC learning starts with an empty rule base and all of rules are generated and learned online, through a simultaneous structure and parameter learning, while the relative parameters are learned through a gradient descent algorithm. The proposed IRSFCMAC is tested by the two benchmarked classification problems and compared with the well-known traditional FCMAC. Experimental results show that the proposed IRSFCMAC model enhanced classification performance results, in terms of accuracy and RMSE.

4:20PM *A Novel Classification Method for Motor Imagery Based on Brain-Computer Interface [#N-14277]*

Chih-Yu Chen, Chun-Wei Wu, Chin-Teng Lin and Shi-An Chen, Brain Research Center, National Chiao Tung University, Taiwan

Brain computer interface (BCI) is known as a good way to communicate between brain and computer or other device. There are many kinds of physiological signal can operate BCI systems. Motor imagery (MI) has been demonstrated to be a good way to operate a BCI system. In some recent studies about MI based BCI systems, low accuracy rate and time consuming are common problems. In this thesis, a novel motor imagery algorithm is proposed to improve the accuracy rate and computational efficiency at the same time. The architecture of many BCI system is quite complex and they involve time consuming processing. The electroencephalography (EEG) signal is the most commonly used inputs for BCI applications but EEG is often contaminated with noise. To overcome such drawbacks, in this paper we use the common spatial pattern (CSP) for feature extraction from EEG and the linear discriminant analysis (LDA) for motor imagery classification. In this study, CSP and LDA have been used to reduce the artifact and classify MI-based EEG signal. We have used two-level cross validation scheme to determine the subject specific best time window and number of CSP features. We have compared the performance of our system with BCI competition results. This novel algorithm with high accuracy rate and efficiency can be applied to real time BCI system in real-life applications.

4:40PM *Motor Imagery Classification for Brain-Computer Interfaces through a Chaotic Neural Network [#N-14421]*

Denis Renato de Moraes Piazentin and Joao Luis Rosa, Universidade de Sao Paulo, Brazil

In this paper, we propose to enhance the detection of control states in online brain-computer interfaces (BCI) with the use of the biologically inspired K-set neural network. This neural network was initially built to model brain waves of small sets of neurons in the brain and later showed a great capability of encoding complex and noisy data into oscillation patterns. We apply the K-set network to classification of motor imagery, a type of mental state very useful for BCI applications. Experimental results show that the network can work efficiently in this task and thus provide better control for BCI applications.

5:00PM *EEG-Based Driving Fatigue Prediction System Using Functional-Link-Based Fuzzy Neural Network [#N-14567]*

Yu-Ting Liu, Yang-Yin Lin, Shang-Lin Wu, Chun-Hsiang Chuang and Chin-Teng Lin, National Chiao Tung University, Taiwan

This study presents a fuzzy prediction system for the forecasting and estimation of driving fatigue, which utilizes a functional-link-based fuzzy neural network (FLFNN) to predict the drowsiness (DS) level in car driving task. The cognitive state in car driving task is one of key issue in cognitive neuroscience because fatigue driving usually causes enormous losses nowadays. The damage can be extremely decreased by the assistant of various artificial systems. Many Electroencephalography (EEG)-based interfaces have been widely developed recently due to its convenient measurement and real-time response. However, the improvement of recognition accuracy is still confined to some specific problems (e.g., individual difference). In order to solve this issue, the proposed methodology in this paper utilizes a nonlinear fuzzy neural network structure to increase the adaptability in the real-world environment. Therefore, this study is further to analysis the brain activities in car driving, which is constructed in a simulated three-dimensional virtual-reality (VR) environment. Finally, through the development of brain cognitive model in car driving task, this system can predict the cognitive state effectively before drivers' action and then provide correct feedback to users. This study also compared the result with the-state-of-art systems, including Linear Regression (LR), Multi-Layer Perceptron Neural Network (MLPNN) and Support Vector Regression (SVR).

Results of this study demonstrate the effectiveness of the proposed FLFNN model.

5:20PM *Developing a Few-Channel Hybrid BCI System by Using Motor Imagery with SSVEP Assist [#N-14821]*

Li-Wei Ko, Shih-Chuan Lin and Meng-Shue Song, National Chiao-Tung University, Taiwan

Generally, Steady-State Visually Evoked Potentials (SSVEP) has widely recognized advantages, like being easy to use, requiring little user training, while Motor Imagery (MI) is not easy to introduce for some subjects. This work introduces a hybrid brain-computer interface (BCI) combines MI and SSVEP strategies -- such an approach allows us to improve performance and universality of the system, and also the number of EEG electrodes from 32 to 3 in central area can increase the efficiency of EEG preprocessing to design an effective and easy way to use hybrid BCI system. In this study the Common Spatial Pattern (CSP) algorithm was introduced as a feature extraction method, which provides a high accuracy in event-related synchronization/desynchronization (ERS/ERD)- based BCI. The four most common classifiers (KNNC, PARZENDC, LDC, SVC) were used for accuracy estimation. Results show that support vector classifier (SVC) and K-nearest-neighbor (KNN) classifier provide better performance than others, and it is possible to reach the same good accuracy using 3-channel (C3, Cz, C4) hybrid BCI system, as with usual 32-channel system.

5:40PM *A Novel BCI-SSVEP Based Approach for Control of Walking in Virtual Environment Using a Convolutional Neural Network [#N-14917]*

Giacomo Tattoli, Domenico Buongiorno, Claudio Loconsole, Daniele Leonardis, Michele Barsotti, Vitoantonio Bevilacqua, Antonio Frisoli and Massimo Bergamasco, Politecnico di Bari, Italy; Scuola Superiore Sant'Anna, Italy

A non-invasive Brain Computer Interface (BCI) based on a Convolutional Neural Network (CNN) is presented as a novel approach for navigation in Virtual Environment (VE). The developed navigation control interface relies on Steady State Visually Evoked Potentials (SSVEP), whose features are discriminated in real time in the electroencephalographic (EEG) data by means of the CNN. The proposed approach has been evaluated through navigation by walking in an immersive and plausible virtual environment (VE), thus enhancing the involvement of the participant and his perception of the VE. Results show that the BCI based on a CNN can be profitably applied for decoding SSVEP features in navigation scenarios, where a reduced number of commands needs to be reliably and rapidly selected. The participant was able to accomplish a waypoint walking task within the VE, by controlling navigation through of the only brain activity.

FrN4-3 Support Vector Machines and Kernel Methods

Friday, July 11, 4:00PM-6:00PM, Room: 305B, Chair: Alessandro Sperduti

4:00PM *Kernel-Based Semi-Supervised Learning for Novelty Detection [#N-14338]*

Van Nguyen, Trung Le, Pham Thien, Mi Dinh and Hoang Thai Le, HCMc University of Pedagogy, Viet Nam; HCMc University of Science, Viet Nam

One-class Support Vector Machine (OCSVM) is a well-known method for novelty detection. However, OCSVM regards all negative data samples as a common symbol and thereby not being able to utilize the information carried by them. Furthermore, OCSVM requires a fully labeled data set and cannot work efficiently with data set with both labeled and unlabeled data samples which is very popular nowadays. In this paper, we first extend the model of OCSVM to enable efficiently using the negative data samples. We then propose two methods to integrate the semi-supervised learning paradigm to the extended model for novelty detection purpose.

4:20PM *Robust Support Vector Machine [#N-14348]*

Trung Le, Dat Tran, Wanli Ma, Thien Pham, Phuong Duong and Minh Nguyen, HCMc University of Pedagogy, Viet Nam; University of Canberra, Viet Nam

Support Vector Machine (SVM) is a well-known kernel-based method for binary classification problem. SVM aims at constructing the optimal middle hyperplane which induces the largest margin. It is proven that in a linearly separable case, this middle hyperplane offers the high accuracy on universal datasets. However, real world datasets often contain overlapping regions and therefore, the decision hyperplane should be adjusted according to the profiles of the datasets. In this paper, we propose Robust Support Vector Machine (RSVM), where the hyperplanes can be properly adjusted to accommodate the real world datasets. By setting the value of the adjustment factor properly, RSVM can handle well the datasets with any possible profiles. Our experiments on the benchmark datasets demonstrate the superiority of the RSVM for both binary and one-class classification problems.

4:40PM *Integrating Bi-Directional Contexts in a Generative Kernel for Trees [#N-14626]*

Davide Bacciu, Alessio Micheli and Alessandro Sperduti, University of Pisa, Italy; University of Padua, Italy

Context is essential to evaluate an atomic piece of information composing an articulated structured sample. A particular context captures different structural information with respect to an alternative context. The paper introduces a generative kernel that easily and effectively combines the structural information captured by generative tree models characterized by different contextual capabilities. The proposed approach exploits the idea of hidden states multisets to realize a tree encoding that takes into account both the summarized information on the path leading to a node (i.e. a top-down context) as well as the information on how substructures are composed to create a subtree rooted on a node (bottom-up context). An thorough experimental analysis is provided, showing that the bi-directional approach incorporating top-down and bottom-up contexts yields to superior performances with respect to the unidirectional contexts alone, achieving state of the art results on challenging tree classification benchmarks.

5:00PM *Large Scale Semi-Supervised Learning Using KSC Based Model [#N-14716]*

Siamak Mehrkanoon and Johan Suykens, KU Leuven, Belgium

Often in practice one deals with a large amount of unlabeled data, while the fraction of labeled data points will typically be small. Therefore one prefers to apply a semi-supervised algorithm, which uses both labeled and unlabeled data points in the learning process, to have a better performance. Considering the large amount of unlabeled data, making a semi-supervised algorithm scalable is an important task. In this paper we adopt a recently proposed multi-class semi-supervised KSC based algorithm (MSS-KSC) and make it scalable by means of two different approaches. The first one is based on the Nystrom approximation method which provides a finite dimensional feature map that can then be used to solve the optimization problem in the primal. The second approach is based on the reduced kernel technique that solves the problem in the dual by reducing the dimensionality of the kernel

matrix to a rectangular kernel. Experimental results demonstrate the scalability and efficiency of the proposed approaches on real datasets.

5:20PM *A Practical SIM Learning Formulation with Margin Capacity Control [#N-14932]*

Thomas Vacek, University of MN, United States

Given a finite i.i.d. dataset of the form (y_i, x_i), the Single Index Model (SIM) learning problem is to estimate a regression of the form u(f(x_i)) where u is some Lipschitz-continuous nondecreasing function and f is a linear function. This paper applies Vapnik's Structural Risk Minimization principle to SIM learning. I show that a risk structure for the space of model functions f gives a risk structure for the space of functions u(f()). Second, I provide a practical learning formulation for SIM using a risk structure defined by margin-based capacity control. The new learning formulation is compared with support vector regression.

5:40PM *Quantized Mixture Kernel Least Mean Square [#N-14953]*

Rosha Pokharel, Sohan Seth and Jose Principe, University of Florida, United States; Helsinki Institute for Information Technology, Finland

Use of multiple kernels in the conventional kernel algorithms is gaining much popularity as it addresses the kernel selection problem as well as improves the performance. Kernel least mean square (KLMS) has been extended to multiple kernels recently using different approaches, one of which is mixture kernel least mean square (MxKLMS). Although this method addresses the kernel selection problem, and improves the performance, it suffers from a problem of linearly growing dictionary like in KLMS. In this paper, we present the quantized MxKLMS (QMxKLMS) algorithm to achieve sub-linear growth in dictionary. This method quantizes the input space based on the conventional criteria using Euclidean distance in input space as well as a new criteria using Euclidean distance in RKHS induced by the sum kernel. The empirical results suggest that QMxKLMS using the latter metric is suitable in a non-stationary environment with abruptly changing modes as they are able to utilize the information regarding the relative importance of kernels. Moreover, the QMxKLMS using both metrics are compared with the QKLMS and the existing multi-kernel methods MKLMS and MKNLMS-CS, showing an improved performance over these methods.

FrN4-4 Feature Extraction and Classification Systems

Friday, July 11, 4:00PM-6:00PM, Room: 305C, Chair: Emil Eirola

4:00PM *Multi-View Uncorrelated Linear Discriminant Analysis with Applications to Handwritten Digit Recognition [#N-14258]*

Mo Yang and Shiliang Sun, East China Normal University, China

Learning from multiple feature sets, which is also called multi-view learning, is more robust than single view learning in many real applications. Canonical correlation analysis (CCA) is a popular technique to utilize information from multiple views. However, as an unsupervised method, it does not exploit the label information. In this paper, we propose an algorithm which combines uncorrelated linear discriminant analysis (ULDA) with CCA, named multi-view uncorrelated linear discriminant analysis (MULDA). Due to the successful application of ULDA, which seeks optimal discriminant features with minimum redundancy in the single view situation, it could be expected that the recognition performance would be enhanced. Experiments on handwritten digit data verify this expectation with results outperforming other related methods.

4:20PM *Differentially Private Feature Selection [#N-14385]*

Jun Yang and Yun Li, Nanjing University of Posts and Telecommunications, China

The privacy-preserving data analysis has been gained significant interest across several research communities. The current researches mainly focus on privacy-preserving classification and regression. However, feature selection is also an essential component for data analysis, which can be used to reduce the data dimensionality and can be utilized to discover knowledge, such as inherent variables in data. In this paper, in order to efficiently mine sensitive data, a privacy preserving feature selection algorithm is proposed and analyzed in theory based on local learning and differential privacy. We also conduct some experiments on benchmark data sets. The Experimental results show that our algorithm can preserve the data privacy to some extent.

4:40PM *A Binary Feature Selection Framework in Kernel Spaces [#N-14425]*

Chengzhang Zhu, Xinwang Liu, Sihang Zhou, Qiang Liu and Jianping Yin, National University of Defense Technology, China

In this paper, we propose a binary feature selection framework in kernel spaces, where each feature is projected into kernel spaces and a binary classification task is constructed in this space. Subsequently, the features are selected according to the normal vector of the learned classifier, which reflects the importance of each feature. To achieve the effect of feature selection, an L1-norm regularization is imposed on the normal vector to enforce its sparsity. Also, our framework can be naturally extended to the semi-supervised feature selection scenario via the well- known manifold regularization technique. Furthermore, the issue of eliminating the potential redundance among the selected features is well discussed. Finally, we provide some theoretical results which guarantee the feasibility of the proposed framework. Comprehensive experiments have been conducted on six benchmark data sets and the results demonstrate the performance of our framework.

5:00PM *A Flexible and Efficient Algorithm for Regularized Marginal Fisher Analysis [#N-14136]*

Jinrong He, Lixin Ding, Lei Jiang and Li Huang, Wuhan University, China; Hunan University of Science and Technology, China; Shanxi University, China

Marginal Fisher analysis (MFA) is a well-known method that considers dimensionality reduction and classification jointly. However, MFA does not utilize the local diversity information of the training data, which will degrade its performance. In order to enhance the discriminant power of MFA, this paper considers introducing local variation quantity to enlarge the distances between local neighborhood embeddings and proposes a flexible and efficient implementation of MFA (F-MFA) within the regularization framework. Therefore, the discriminant structure and diversity of data are preserved in low-dimensional subspace. Computationally, F-MFA is formulated as a trace differential optimization problem which can completely avoids the singularity problem as it exists in MFA. Further, an efficient algorithm is developed for implementing F-MFA via QR-decomposition. Experimental results on four face data sets demonstrate the effectiveness of our approach.

5:20PM *Estimation of Individual Prediction Reliability Using Error Analysis Applied to Short-Term Load Forecasting Problem [#N-14516]*

Elia Matsumoto and Emilio Del-Moral-Hernandez, University of Sao Paulo, Brazil

This work describes the methodology to create a reliability estimate for individual predictions in regressions. This estimate is define as a binary variable which indicates if the regression error of an individual unseen observation is likely to be critical or not, according to a meaningful criterion previously defined by the regression model user. The approach is based on the construction of a model to separate these two classes of error. The method was evaluated on sixteen experiments applied to short-time load forecasting regression problem using eight databases from ISO New England. In these experiments, the models for pattern recognition were built as ensembles composed of three classification models: K-Nearest Neighbors, Neural Network Committee Machine, and Support Vector Machine. The obtained results showed that the Ensemble Classifiers were consistently able to detect critical error cases.

5:40PM *The Delta Test: The 1-NN Estimator as a Feature Selection Criterion [#N-14309]*

Emil Eirola, Amaury Lendasse, Francesco Corona and Michel Verleysen, Aalto University, Finland; Universite catholique de Louvain, Belgium

Feature selection is essential in many machine learning problem, but it is often not clear on which grounds variables should be included or excluded. This paper shows that the mean squared leave-one-out error of the first-nearest-neighbour estimator is effective as a cost function when selecting input variables for regression tasks. A theoretical analysis of the estimator's properties is presented to support its use for feature selection. An experimental comparison to alternative selection criteria (including mutual information, least angle regression, and the RReliefF algorithm) demonstrates reliable performance on several regression tasks.

FrN4-5 Machine Learning and Applications II

Friday, July 11, 4:00PM-6:00PM, Room: 305D, Chair: Giacomo Boracchi

4:00PM *Improved Biogeography-Based Optimization Approach to Secondary Protein Prediction [#N-14095]*

Ruisong Fan, Haibin Duan and Guangming Xie, Beihang University, China; Peking University, China

In recent years, many intelligent algorithms have been proposed to solve constraint problems. Biogeography-Based Optimization (BBO) is one of these newly proposed optimization algorithms. As a new way to solve optimization problems, BBO has quick convergence. In this paper, we proposed an improved BBO for solving protein structure prediction problems. We propose an extension of BBO by improving its migration method. Comparative experiments with standard BBO and differential evolution (DE) are conducted, and the results have verified the feasibility of effectiveness of our proposed BBO in solving nonlinear protein prediction problems.

4:20PM *Integrating Self-Organizing Neural Network and Motivated Learning for Coordinated Multi-Agent Reinforcement Learning in Multi-Stage Stochastic Game [#N-14398]*

Teck-Hou Teng, Ah-Hwee Tan, Janusz Starzyk, Yuan-Sin Tan and Loo-Nin Teow, Nanyang Technological University, Singapore; Ohio University, United States; DSO National Laboratories, Singapore

Most non-trivial problems require the coordinated performance of multiple goal- oriented and time-critical tasks. Coordinating the performance of the tasks is required due to the dependencies among the tasks and the sharing of resources. In this work, an agent learns to perform a task using reinforcement learning with a self-organizing neural network as the function approximator. We propose a novel coordination strategy integrating Motivated Learning (ML) and a self-organizing neural network for multi-agent reinforcement learning (MARL). Specifically, we adapt the ML idea of using pain signal to overcome the resource competition issue. Dependency among the agents is resolved using domain knowledge of their dependence. To avoid domineering agents, the task goals are staggered over multiple stages. A stage is completed by attaining a particular combination of task goals. Results from our experiments conducted using a popular PC-based game known as Starcraft Broodwar show goals of multiple tasks can be attained efficiently using our proposed coordination strategy.

4:40PM *Extracting Temporal Knowledge from Time Series: A Case Study in Ecological Data [#N-14847]*

Reggio Hartono, Russel Pears, Nikola Kasabov and Susan Worner, Auckland University of Technology, New Zealand; Lincoln University, New Zealand

This research presents a generic framework and methods for mining temporal rules from multiple time-series data and its application to ecological data. The aphids dataset that tracks the trajectory of aphid infestations over time has been well researched in a number of studies. Those studies concentrated on predicting the scale of infestation over time. The focus of our research is to identify environmental factors that predict, in a temporal fashion, high incidence of aphid activity. This required the development of a novel framework for knowledge extraction from multiple time-series data and a method for discretization of numeric data as well-known methods such as SAX did not perform adequately due to the non-Gaussian nature of the data involved. Our experimentation yielded new insights into the environmental factors that may influence pest outbreak which are captured in the form of simple actionable rules that would be of interest to the farming community.

5:00PM *Planning-Driven Behavior Selection Network for Controlling a Humanoid Robot [#N-14852]*

Yu-Jung Chae and Sung-Bae Cho, the Computer Science Department, Yonsei, Korea, Republic of

A humanoid robot generates behaviors by utilizing uncertain sensor data. However, because of errors arising from the control process, these behaviors may not be implemented completely. What is more, an efficiently configured humanoid robot should be able to overcome simple and complex problems at the same time doing it according to the user's request. In this paper, we propose a humanoid robot control system which employs a reactive, behavior-based method called Behavior Selection Network (BSN), enabling the robot to respond robustly in a rapidly changing environment. This method also facilitates in achieving short-term goals by the use of goal-oriented features. Also, to address BSN's limitation in solving complex problems, we integrate a plan-based method into the system called STRIPS planning, resulting to a control system that can resolve both the user's simple and complex requests while being able to respond to various environments quickly and properly. Moreover, since the BSN and STRIPS planning structures are internally independent, the proposed system is flexibly scalable to cumulative user requests. We confirm the control system's usability by performing several test scenarios on NAO robot. Experiments show that the proposed system is able to cope efficiently in a rapidly changing environment as well as deliver user's requests properly, achieving an accuracy of 85.7% on the experiments.

5:20PM *Sliding Window-Based Analysis of Multiple Foreign Exchange Trading Systems by Using Soft Computing Techniques [#N-14786]*

Rodrigo Brito and Adriano Oliveira, Federal University of Pernambuco, Brazil

Considerable effort has been made by researchers from various areas of science to forecast financial time series such as stock market and foreign exchange market. Recent studies have shown that the market can be outperformed by trading systems built with soft computing techniques. This paper aims to compare different trading systems based on support vector regression (SVR), growing hierarchical self- organizing maps (GHSOM) and genetic algorithms (GA) when tested against nine currency pairs of the foreign exchange market (Forex). The experiments were performed using the sliding window strategy. The results showed that the GA-based trading systems outperformed the SVR+GHSOM model when evaluated by four performance metrics, including an statistical test.

5:40PM *Learning in Dynamic Decision Making: The Usability Process [#N-14628]*

Liana Stanca, Ramona Lacurezeanu and Cristina Felea, Babes-Bolyai University, Romania

Usability of websites is an important issue for any entity operating in the virtual environment. Dynamic decision refers to the ability to choose (evaluate) between different actions at different points in time, in order to control and optimize performance. Currently, increasing attention is paid to the role of informal learning in the adaptation of learning to individual needs and circumstances in order to maximize knowledge. This paper approaches usability in the context of the theory of dynamic decisions. In the authors' view, the usability evaluation of a website becomes efficient on condition that it is repeated over time with the same group of individuals, resulting in a learning situation. The experiment consisted of measuring usability on a sample of individuals (experts) at consecutive time points to determine the degree of similarity of their behavior during the evaluation process. Starting from these assumptions, we demonstrated that usability may be considered a dynamic process, which could be very useful in reorganizing websites by identifying areas of intervention for the purpose of allowing users to learn and thus getting maximum effect from dynamic decisions.

FrN4-6 Neuromorphic Hardware

Friday, July 11, 4:00PM-6:00PM, Room: 305E, Chair: Eros Pasero

4:00PM *Majority Neuron Circuit Having Large Fan-in with Non-Volatile Synaptic Weight [#N-14624]*

Akima Hisanao, Katayama Yasuhiro, Nakajima Koji, Sakuraba Masao and Sato Shigeo, Research Institute of Electrical Communication Tohoku University, Japan; Toshiba Corporation Semiconductor and Storage Products Company, Japan

We present a design of a majority neuron circuit with non-volatile synaptic weights. It is based on an analog majority circuit composed of controlled current inverters (CCIs). The proposed circuit is immune to device parameter fluctuations, and its fan-in is estimated about 1000. Synaptic weights are realized on the neuron circuit by adding variable resistors. We consider a design of a non-volatile synaptic weight by using a three-terminal magnetic domain-wall motion (DWM) device. The operation of a fully connected recurrent neural network composed of the proposed circuits has been confirmed by SPICE simulation.

4:20PM *Accelerating Pattern Matching in Neuromorphic Text Recognition System Using Intel Xeon Phi Coprocessor [#N-14643]*

Khadeer Ahmed, Qinru Qiu, Parth Malani and Mangesh Tamhankar, Syracuse University, United States; Intel Corporation, United States

Neuromorphic computing systems refer to the computing architecture inspired by the working mechanism of human brains. The rapidly reducing cost and increasing performance of state-of-the-art computing hardware allows large-scale implementation of machine intelligence models with neuromorphic architectures and opens the opportunity for new applications. One such computing hardware is Intel Xeon Phi coprocessor, which delivers over a TeraFLOP of computing power with 61 integrated processing cores. How to efficiently harness such computing power to achieve real time decision and cognition is one of the key design considerations. This paper presents an optimized implementation of Brain-State- in-a-Box (BSB) neural network model on the Xeon Phi coprocessor for pattern matching in the context of intelligent text recognition of noisy document images. From a scalability standpoint on a High Performance Computing (HPC) platform we show that efficient work-load partitioning and resource management can double the performance of this many-core architecture for neuromorphic applications.

4:40PM *Optimising the Overall Power Usage on the SpiNNaker Neuromimetic Platform [#N-14733]*

Evangelos Stromatias, Cameron Patterson and Steve Furber, University of Manchester, United Kingdom

Simulations of biological tissue have been exten- sively used to replicate phenomena observed in-vivo and in- vitro experiments as an alternative methodology for explaining how computations could take place in a brain region. General-purpose supercomputers provide the computational power and parallelism required to implement highly complex neural models, but this comes at the expense of high power requirements and communication overheads. Moreover, there are certain cases where real-time simulation performance is a desirable feature, for example in the field of cognitive robotics where embodied agents need to interact with their environment through biologically inspired asynchronous sensors. The spinnaker neuromimetic platform is a scalable architecture, that has been designed to enable energy-efficient, large- scale simulations of spiking neurons in biological real- time. This work is based on a recent study which revealed that while they are generally energy efficient, SpiNNaker chips dissipate significant amount of power while in idle state. In this paper, we perform a systematic investigation into the overall energy consumption of a SpiNNaker system and propose a number of optimised suspend modes in order to reduce this. The proposed implementation is 60% more energy efficient in the idle state, 50% in the uploading and 52% in the downloading phases, while the power dissipation of the whole simulation is reduced by 52%. For demonstration purposes, we run a neural network simulation comprising thousands of neurons and millions of complex synapses on a 48-chip SpiNNaker board, generating millions of synaptic events per second.

5:00PM *Efficient Implementation of STDP Rules on SpiNNaker Neuromorphic Hardware [#N-14788]*

Peter U. Diehl and Matthew Cook, Institute of Neuroinformatics, ETH Zurich and University Zurich, Switzerland

Recent development of neuromorphic hardware offers great potential to speed up simulations of neural networks. SpiNNaker is a neuromorphic hardware and software system designed to be scalable and flexible enough to implement a variety of different types of simulations of neural systems, including spiking simulations with plasticity and learning. Spike-timing dependent plasticity (STDP) rules are the most common form of learning used in spiking networks. However, to date very few such rules have been implemented on SpiNNaker, in part because implementations must be

designed to fit the specialized nature of the hardware. Here we explain how general STDP rules can be efficiently implemented in the SpiNNaker system. We give two examples of applications of the implemented rule: learning of a temporal sequence, and balancing inhibition and excitation of a neural network. Comparing the results from the SpiNNaker system to a conventional double-precision simulation, we find that the network behavior is comparable, and the final weights differ by less than 3% between the two simulations, while the SpiNNaker simulation runs much faster, since it runs in real time, independent of network size.

5:20PM *Robust Doublet STDP in a Floating-Gate Synapse [#N-14411]*

Roshan Gopalakrishnan and Arindam Basu, Nanyang Technological University, Singapore

Learning in a neural network typically happens with the modification or plasticity of synaptic weight. Thus the plasticity rule which modifies the synaptic strength based on the timing difference between the pre- and post-synaptic spike occurrence is termed as Spike Time Dependent Plasticity (STDP). This paper describes the neuromorphic VLSI implementation of a synapse utilizing a single floating-gate (FG) transistor that can be used to store a weight in a nonvolatile manner and demonstrate biological learning rules such as Long-Term Potentiation (LTP), Long-Term Depression (LTD) and STDP. The experimental STDP plot of a FG synapse (change in weight against delta t=tpost - tpre from previous studies shows a depression instead of potentiation at some range of positive values of delta t for a wide set of parameters. In this paper, we present a simple solution based on changing control gate waveforms of the FG device that makes the weight change conform closely with biological observations over a wide range of parameters. We show results from a theoretical model to illustrate the effects of the modified waveform. The experimental results from a FG synapse fabricated in AMS 0.35um CMOS process design are also presented to justify the claim.

5:40PM *Clustering and Synchronous Firing of Coupled Rulkov Maps with STDP for Modeling Epilepsy [#N-14931]*

Naohiro Shibuya, Charles Unsworth, Yoko Uwate and Yoshifumi Nishio, The University of Tokushima, Japan; The University of Auckland, New Zealand

Epilepsy of the neuropsychiatric disorder is provoked from an imbalance in the long-term potentiation (LTP) versus long-term depression (LTD) of the synapses in the hippocampus. The LTP and LTD are replicated by using the Spike Timing Dependent Plasticity (STDP). Additionally, the spiking activity of the synapses in the hippocampus can be approximated by using the Rulkov maps. In our previous study, we considered some easy simulation models which are constructed by using Rulkov maps with STDP. Moreover, these simulation models consist of unidirectionally coupled neurons. In this paper, we consider some easy simulation models with bidirectionally coupled neurons. We explore the effect of unidirectional and bidirectional connection on spiking activity, as basic simulation for constructing the approximate simulation model of epilepsy. From these results, the unidirectional models show high accuracy in-phase/anti- phase synchronization, and it shows divergent relatively early. The bidirectional models show the stable waveform (i.e., non-divergent) for a long term compared to unidirectional models.

DETAILED PROGRAM (FUZZ-IEEE 2014)

Monday, July 7, 1:30PM-3:30PM

Special Session: MoF1-1 Fuzzy Decision-Making: Consensus and Missing Preferences I

Monday, July 7, 1:30PM-3:30PM, Room: 201A, Chair: Francisco Chiclana and Enrique Herrera-Viedma

1:30PM *Two Consensus Models Based on the Minimum Cost and the Maximum Return [#F-14049]*
Zaiwu Gong, Huanhuan Zhang, Chonglan Guo, Xiaoxia Xu and Chao Xu, Nanjing University of Information Science and Technology, China

This paper proposes two kinds of minimum cost models regarding all the individuals and regarding with one particular individual respectively, shows the economic significance of these two models by exploring their dual models based on the primal-dual linear programming theories, and builds the conditions when these two models have the same optimal consensus opinion.

1:50PM *A New Approach for Delphi Processes Based on Group Consensus with Linguistic Terms [#F-14181]*
Nuria Agell, Christ Jan Ganzewinkel, Monica Sanchez, Llorenc Rosello, Francesc Prats and Peter Andriessen, ESADE-URL, Spain; Maxima Medical Center, Netherlands; UPC-BarcelonaTech, Spain

A new approach for Delphi processes including a measure of consensus based on linguistic terms is introduced in this paper. The measure of consensus involves qualitative reasoning techniques and is based on the concept of entropy. In the proposed approach, consensus is reached automatically without the need for neither a moderator nor a final interaction among panelists. In addition, it permits panelists to answer with different levels of precision depending on their knowledge on each question. An illustrative example considering the opinions of stake holders in neonate health-care to reach a final consensual definition of chronic pain in neonates.

2:10PM *A Hybrid Weighted Aggregation Method Based on Consistency and Consensus in Group Decision Making [#F-14239]*
Feng Zhang, Joshua Ignatius, Chee Peng Lim and Yong Zhang, Universiti Sains Malaysia, Malaysia; Deakin University, Australia; University of Hong Kong, Hong Kong

A recent study in Science indicated that the confidence of a decision maker played an essential role in group decision making problems. In order to make use of the information of each individual's confidence of the current decision problem, a new hybrid weighted aggregation method to solve a group decision making peoblem is proposed in this paper. Specifically, the hybrid weight of each expert is generated by a convex combination of his/her subjective experience-based weight and objective problem-domain-based weight. The experience-based weight is derived from the expert's historical experiences and the problem-domain-based weight is characterized by the confidence degree and consensus degree of each expert's opinions in the current decision making process. Based on the hybrid weighted aggregation method, all the experts' opinions which are expressed in the form of fuzzy preference relations are consequently aggregated to obtain a collective group opinion. Some valuable properities of the proposed method are discussed. A nurse manager hiring problem in a hospital is employed to illustrate that the proposed method provides a rational and valid solution for the group decision making problem when the experts are not willing to change their initial preferences, or the cost of change is high due to time limitation.

2:30PM *Multiperson Decision Making with Different Preference Representation Structures: A Selection Process Based on Prospect Theory [#F-14037]*
Yucheng Dong, Nan Luo and Hengjie Zhang, Sichuan University, China

In this study, we present a novel selection process to solve the multiperson decision making (MPDM) problems with different preference representation structures. This selection process is based on the prospect theory, which is one of the most influential psychological behavior theories, and seeks to maximize the satisfactory of all decision makers. Specifically, the individual selection methods associated with different preference structures are used to obtain individual preference orderings. Then, the preference-approval structures are used to determine the reference points of the prospect theory, according to the obtained individual preference orderings. Next, the gains and losses are calculated based on the prospect theory and the established reference points. Finally, the prospect values of the alternatives are obtained to rank the alternatives.

2:50PM *Can Indices of Ecological Evenness Be Used to Measure Consensus? [#F-14116]*
Gleb Beliakov, Simon James and Dale Nimmo, Deakin University, Australia

In the context of group decision making with fuzzy preferences, consensus measures are employed to provide feedback and help guide automatic or semi-automatic decision reaching processes. These measures attempt to capture the intuitive notion of how much inputs, individuals or groups agree with one another. Meanwhile, in ecological studies there has been an ongoing research effort to define measures of community evenness based on how evenly the proportional abundances of species are distributed. The question hence arises as to whether there can be any cross-fertilization from developments in these fields given their intuitive similarity. Here we investigate some of the models used in ecology toward their potential use in measuring consensus. We found that although many consensus characteristics are exhibited by evenness indices, lack of reciprocity and a tendency towards a minimum when a single input is non-zero would make them undesirable for inputs expressed on an interval scale. On the other hand, we note that some of the general frameworks could still be useful for other types of inputs like ranking profiles and that in the opposite direction consensus measures have the potential to provide new insights in ecology.

3:10PM *Multiplicative Consistency for Interval Additive Reciprocal Preference Relations [#F-14009]*
Jian Wu and Francisco Chiclana, Zhejiang Normal University, China; De Montfort University, United Kingdom

The multiplicative consistency (MC) property of interval valued reciprocal preference relations (IVRPRs) is explored, and then the consistency index is quantified by the multiplicative consistency estimated IVRPR. The MC property is used to measure the level of consistency of the information provided by the experts and also to propose the consistency index induced ordered weighted averaging (CI-IOWA) operator. The novelty of this operator is that it aggregates individual IVRPRs in such a way that more importance is put on the most consistent ones. Finally, an approach for group decision making problems with IVRPRs is proposed

Special Session: MoF1-2 Lattice Computing

Monday, July 7, 1:30PM-3:30PM, Room: 201B, Chair: Vassilis Kaburlasos

1:30PM *Lattice Computing (LC) Meta-Representation for Pattern Classification [#F-14222]*

George Papakostas and Vassilis Kaburlasos, Eastern Macedonia and Thrace Institute of Technology, Greece

This paper compares two alternative feature data meta-representations using Intervals' Numbers (INs) in the context of the Minimum Distance Classifier (MDC) model. The first IN meta-representation employs one IN per feature vector, whereas the second IN meta-representation employs one IN per feature per class. Comparative classification experiments with the standard minimum distance classifier (MDC) on two benchmark classification problems, regarding face/facial expression recognition, demonstrate the superiority of the aforementioned second IN meta-representation. This superiority is attributed to an IN's capacity to represent discriminative, all-order data statistics in a population of features.

1:50PM *Two Lattice Metrics Dendritic Computing for Pattern Recognition [#F-14048]*

Gerhard X. Ritter, Gonzalo Urcid and Juan-Carlos Valdiviezo-N, University of Florida, United States; National Institute of Astrophysics, Optics, and Electronics, Mexico; Polytechnical University of Tulancingo, Mexico

An artificial neural network model based on dendritic computation using two lattice metrics is introduced in this paper. A description of the mathematical framework of the proposed model is provided and its corresponding learning algorithm is presented in mathematical pseudocode. Computational experiments are given to demonstrate the effectiveness and performance of the learning algorithm as well as its application to some illustrative pattern recognition problems.

2:10PM *An Introduction to the Max-Plus Projection Autoassociative Morphological Memory and Some of Its Variations [#F-14130]*

Marcos Eduardo Valle, University of Campinas, Brazil

In this paper, we present a novel lattice-based memory model called max-plus projection autoassociative morphological memory (max-plus PAMM). The max-plus PAMM yields the largest max-plus combination of the stored patterns which is less than or equal to the input. Such as the original autoassociative morphological memories (AMMs), it is idempotent and it gives perfect recall of undistorted patterns. Furthermore, the max-plus PAMM is very robust to dilative noise and it has less spurious memories than its corresponding AMM. This paper also presents two variations of the max-plus PAMM. The first yields the max-plus combination that is the Chebyshev-best approximation of the input while the second uses a noise masking strategy.

2:30PM *FCknn: A Granular knn Classifier Based on Formal Concepts [#F-14303]*

Vassilis Kaburlasos, Vassilis Tsoukalas and Lefteris Moussiades, Eastern Macedonia and Thrace Institute of Technology, Greece

Recent work has proposed an enhancement of Formal Concept Analysis (FCA) in a tunable, hybrid formal context including both numerical and nominal data. This work introduces FCknn, that is a granular knn classifier based on hybrid concepts, whose effectiveness is demonstrated on benchmark datasets from the literature including both numerical and nominal data. Preliminary experimental results compare well with the results by alternative classifiers from the literature. Formal concepts are interpreted as descriptive decision-making knowledge (rules) induced from the data.

2:50PM *One Side Lattice Memory Reduced Ordering Function Allows Discrimination in Resting State fMRI [#F-14258]*

Manuel Grana and Darya Chyzhyk, University of Basque Country, Spain

Currently there is a lot effort to define neurological biomarkers from resting state fMRI data for different neurological diseases. fMRI voxels are high dimensional vectors, so that dimensional reduction, to scalar values if possible, is highly desirable. At the same time, biomarkers are to be provided as brain localizations which may have an anatomical interpretation. A general procedure consists in the reduction of fMRI data to scalar values, which are then entered in a feature selection process to obtain the desired localizations of discriminant voxel sites sites in the brain. These voxel sites may be interpreted as biomarkers. Classification is performed on the feature vectors extracted from the selected brain voxel sites. In this paper, we follow an approach born from Multivariant Mathematical Morphology in order to obtain meaningful orderings on multivariate data. We define a supervised h-ordering defined on the fMRI time series by the response of Lattice Auto-associative Memories (LAAM) built from specific fMRI voxels. Instead of performing morphological processing based on the induced ordering, we use the LAAM supervised h-function map for feature selection and feature extraction. We perform a classification experiment on a set of resting state fMRI images of schizophrenia patients with and without a history of auditive hallucinations obtaining high accuracy with one side LAAM h-function.

3:10PM *Lattice-Valued Fuzzy Residual Finite Automata [#F-14279]*

Fugang Zhang and Yongming Li, School of mathematics and statistics of Huangshan University, China

In this paper, we introduce the notion of lattice-valued fuzzy residual finite automaton (LRFA) and the LRFA-regular language with membership values in a complete residuated lattice and discuss some properties of the LRFA. Next, we define saturation operator and reduction operator on lattice-valued finite automata(LFA), which provide a way to simplify LRFA based on their closure properties in LRFA. At last, we define the canonical LRFA based on the notion of irreducible residual language, prove that every LRFA-regular language is recognized by a unique canonical LRFA which has a minimal number of states and largest initial and transition functions.

MoF1-3 Fuzzy Control & Intelligent Systems I

Monday, July 7, 1:30PM-3:30PM, Room: 201C, Chair: Hamid Berenji and Zhijun Li

1:30PM *Weighted Fuzzy Fault Tolerant Model Predictive Control [#F-14523]*

Manikandan Pandiyan, Geetha Mani and Jovitha Jerome, PSG College of Technology, India

This paper proposes a new active fault-tolerant control (FTC) using fuzzy predictive logic. The FTC approach is based on two steps, fault detection and isolation (FDI) and fault accommodation. The fault detection is performed by a model-based approach using fuzzy modeling and fault isolation uses a fuzzy decision making approach. The information obtained on the FDI step is used to select the model to be used in fault accommodation, in a model predictive control (MPC) scheme. The fault accommodation is performed with one fuzzy model for each identified fault. The FTC scheme is used to accommodate the faults of real-time CSTR level process. The fuzzy FTC scheme proposed in this paper was able to detect, isolate and accommodate correctly the considered faults of the system.

1:50PM *Delay-Dependent Local Stabilization of Nonlinear Discrete-Time System Using T-S Models through Convex Optimization [#F-14528]*

Luis Silva, Valter Leite, Eugenio Castelan and Feng Gang, Universidade Federal de Santa Catarina, Brazil; CEFET-MG and Campus Divinopolis, Brazil; City University of Hong Kong, China

In this paper we develop convex delay-dependent conditions in terms of linear matrix inequalities (LMIs) for the synthesis of fuzzy stabilizing feedback controllers. The condition is developed from a novel Lyapunov-Krasovskii fuzzy function. We consider that the T-S fuzzy model represents the nonlinear system only inside a region of validity. Because of this, we determine a domain of stability inside the region of validity, such that the trajectories of the nonlinear system in closed-loop starting from this domain converge asymptotically to origin. The domain of stability is characterized through a Cartesian product of two sets, where the first one is used to treat the initial state vector at the sample k=0, and the second set is used to treat the delayed state vectors and the difference between two sampling of the delayed state vectors. We also develop a convex optimization problem to compute the gains of the fuzzy controllers to maximize the domain of stability. Finally, we show an example to demonstrate the developed conditions.

2:10PM *SNAC Based Near-Optimal Controller for Robotic Manipulator with Unknown Dynamics [#F-14397]*

Samrat Dutta and Laxmidhar Behera, Indian Institute of Technology Kanpur, India

A near optimal control technique for robotic manipulator with completely unknown dynamics is described in this work. Obtaining the optimal control law u* depends on solving Hamilton Jacobi Bellman equation but getting an analytic solution is not possible for unknown models. It is shown that instead of solving HJB equation analytically, the optimal control law can be obtained through learning of a Single Network Adaptive Critic (SNAC). The generic nonlinear model of manipulator dynamics is represented as Takagi-Sugeno-Kang fuzzy combination of local linear models. A stabilizing fixed gain controller is designed for the TSK fuzzy system using an unconventional Lyapunov function that is used to represent the value function. Stable Lyapunov P matrices are selected using the Genetic Algorithm (GA) Toolbox in Matlab. This approach avoids the learning of initial cost that can be accumulated by an existing controller. The critic is trained to approximate the optimal cost J* by renewing the policy in iterations. Validation of the proposed technique is done through simulation on a robotic manipulator model. Results show the effectiveness of the presented work.

2:30PM *Robust Adaptive Type-2 Fuzzy Logic Controller Design for a Flexible Air-Breathing Hypersonic Vehicle [#F-14486]*

Fang Yang, Jianqiang Yi, Xiangmin Tan and Ruyi Yuan, Institute of Automation, Chinese Academy of Sciences, China

A robust adaptive type-2 fuzzy logic controller is designed for the longitudinal dynamics of a flexible air-breathing hypersonic vehicle. The aircraft's pitch motion and flexible vibration are strongly coupled explicitly in the dynamic equations. The throttle setting is designed to control the velocity by dynamic inversion control method. The elevator deflection is designed to stabilize the pitch rate and flexible modes and in the end control the altitude in a stepwise manner by backstepping control method. The flexible modes are actively used in the control design in order to counteract both the tracking errors and the flexible vibrations. The virtual control signals in backstepping control as well as their derivatives are obtained by command filters whose magnitudes, bandwidths and rate limit constraints can be set. The transition processes of the velocity and altitude commands are also obtained by command filters. Uncertainties are estimated online by interval type-2 adaptive fuzzy logic system. The adaptive law of the fuzzy logic system is derived by Lyapunov synthesis approach. Simulation results demonstrate the effectiveness and robustness of the proposed controller and also validate type-2 fuzzy logic is more capable of handling uncertainties than type-1 fuzzy logic.

2:50PM *Attitude Tracking Control for Hypersonic Vehicles Based on Type-2 Fuzzy Dynamic Characteristic Modeling Method [#F-14488]*

Xiong Luo, Feng Liu and Fuchun Sun, University of Science and Technology Beijing, China; Tsinghua University, China

It is obvious that the highly nonlinear nature of dynamic behavior in hypersonic vehicle system impose very challenging obstacles to the controller design. In this paper, we discuss the design of a novel type-2 fuzzy dynamic characteristic modeling method to attitude tracking control problem for hypersonic vehicles in gilding phase. The type-2 (T2) fuzzy logic is introduced into the characteristic modeling (CM) method. Unlike the traditional fuzzy dynamic modeling method normally with a fixed local linear model in every fuzzy subspace, our approach performs CM in subspace, which actually can handle the nonlinearity well while reducing the number of fuzzy rules. After dividing the whole restriction region into several subspaces, the whole nonlinear system can be regarded as a T2 fuzzy "blending" of each individual characteristic model. Then this novel T2 fuzzy logic system modelled by decomposition of a complex nonlinear system into a collection of local CMs, can overcome the deficiencies of traditional fuzzy dynamic modeling and CM approaches. Therefore, it can achieve a better trade-off between tracking accuracy and convergence efficiency in the controller design for hypersonic vehicles. Simulation results under the conditions of certainty and uncertainty are given to show the effectiveness of the novel method for the attitude tracking control of hypersonic vehicles in gilding phase.

3:10PM *Sliding Mode Control of Fuzzy Descriptor Systems with Time Delay [#F-14513]*

Mourad Kchaou and Ahmed El Hajjaji, University of Sfax, Tunisia; University of Picardie Jules Verne Modelling, France

This paper investigates the problem of sliding mode control (SMC) for a class of uncertain Takagi-Sugeno (TS) fuzzy descriptor systems with time-varying delay. An integral- type sliding function is proposed and a new delay-dependent stability criterion, in terms of linear matrix inequality(LMI), is derived which guarantees to the sliding mode dynamics to be regular, impulse free and stable for all admissible uncertainties and time-varying delay. Moreover, a SMC law is synthesized to ensure the reaching condition. A numerical example is given to demonstrate the effectiveness of the proposed method SMC scheme.

MoF1-4 Fuzzy Logic and Fuzzy Set Theory I

Monday, July 7, 1:30PM-3:30PM, Room: 201D, Chair: Vladik Kreinovich and Yongming Li

1:30PM *Cauchy-Like Functional Equation Based on a Class of Uninorms [#F-14030]*

Feng Qin, Jiangxi Normal University, China

Commuting is an important property in any two-step information merging procedure where the results should not depend on the order in which the single steps are performed. In the case of bisymmetric aggregation operators with the neutral elements, Saminger, Mesiar and Dubois, already reduced characterization of commuting n-ary operators to resolving the unary distributive functional equations, but only some sufficient conditions of unary functions distributive over two particular classes of uninorms are given out. Along this way of thinking, in this paper, we will investigate and fully characterize the following functional equation f(U(x,y))=U(f(x),f(y)), where f\colon[0,1]\rightarrow[0,1] is an unknown function, a uninorm U\in{\mathcal U}_{\min} has a continuously underlying t-norm T_U and a continuously underlying t-conorm S_U. Our investigation shows the key point is a transformation from this functional equation to the several known ones. Moreover, this equation has non-monotone solutions different completely with those obtained ones.

1:50PM *Data Driven Fuzzy Membership Function Generation for Increased Understandability [#F-14043]*

Dumidu Wijayasekara and Milos Manic, University of Idaho, United States

Fuzzy Logic Systems (FLS) are a well documented proven method for various applications such as control classification and data mining. The major advantage of FLS is the use of human interpretable linguistic terms and rules. In order to capture the uncertainty inherent to linguistic terms, Fuzzy Membership Functions (MF) are used. Therefore, membership functions are essential for improving the understandability of fuzzy systems. Optimizing FLS for improved accuracy in terms of classification or control can reduce the understandability of fuzzy MFs. Expert knowledge can be used to derive MFs, but it has been shown that this might not be optimal, and acquiring expert knowledge is not trivial. Therefore, this paper presents a data driven method using statistical methods to generate membership functions that describe the data while maintaining the understandability. The presented method calculates key points such as membership function centers, intersections and slopes using data driven statistical methods. Furthermore, the presented method utilizes several understandability metrics to adjust the generated MFs. The presented method was tested on several benchmark datasets and a real-world dataset and was shown to be able to generate MFs that describe the dataset, while maintaining high levels of understandability.

2:10PM *A Fuzzy Directional Distance Measure [#F-14086]*

Josie McCulloch, Chris Hinde, Christian Wagner and Uwe Aickelin, University of Nottingham, United Kingdom; Loughborough University, United Kingdom

The measure of distance between two fuzzy sets is a fundamental tool within fuzzy set theory, however, distance measures currently within the literature use a crisp value to represent the distance between fuzzy sets. A real valued distance measure is developed into a fuzzy distance measure which better reflects the uncertainty inherent in fuzzy sets and a fuzzy directional distance measure is presented, which accounts for the direction of change between fuzzy sets. A multiplicative version is explored as a full maximal assignment is computationally intractable so an intermediate solution is offered.

2:30PM *Hierarchy of Lattice-Valued Fuzzy Automata and Decidability of Their Languages [#F-14098]*

Qianqian Xue, Lei Li and Yongming Li, Shaanxi Normal University, China; Northwestern Polytechnical University, China

In this paper, the role of local finiteness of truth values domain of fuzzy automata is analyzed, in which the truth value domain of fuzzy automata is the (commutative) lattice-ordered monoid. We introduce a hierarchy of lattice-valued fuzzy finite automata and the languages which were recognized by these automata. Besides, the role of local finiteness of truth value domain of fuzzy languages to the hierarchy of fuzzy automata, the role of some special archimedean t-norms in the hierarchy of fuzzy automata and the decidability of lattice-valued languages are also discussed.

2:50PM *Analysing Fuzzy Sets through Combining Measures of Similarity and Distance [#F-14219]*

Josie McCulloch, Christian Wagner and Uwe Aickelin, University of Nottingham, United Kingdom

Reasoning with fuzzy sets can be achieved through measures such as similarity and distance. However, these measures can often give misleading results when considered independently, for example giving the same value for two different pairs of fuzzy sets. This is particularly a problem where many fuzzy sets are generated from real data, and while two different measures may be used to automatically compare such fuzzy sets, it is difficult to interpret two different results. This is especially true where a large number of fuzzy sets are being compared as part of a reasoning system. This paper introduces a method for combining the results of multiple measures into a single measure for the purpose of analysing and comparing fuzzy sets. The combined measure alleviates ambiguous results and aids in the automatic comparison of fuzzy sets. The properties of the combined measure are given, and demonstrations are presented with discussions on the advantages over using a single measure.

3:10PM *Aggregating Fuzzy Implications Based on OWA-Operators [#F-14448]*

Ibero Benitez, Rosana Zanotelli, Renata Reiser, Simone Costa, Luciana Foss and Adenauer Yamin, Federal University of Pelotas, Brazil

This paper presents the fuzzy (S,N)- QL- and D-subimplication classes, which are obtained by OWA operators performed over the families of triangular subnorms and subconorms along with fuzzy negations. Since these classes of subimplications are explicitly represented by such connectives, the corresponding (S,N)- QL- and D-subimplicatio are characterized by the generalized associativity and distributive properties together with extensions of the exchange and neutrality principles. As the main results, these families of subimplications extend related implications by preserving their corresponding properties.

Monday, July 7, 3:30PM-6:00PM

Poster Session: PF1 Fuzzy Clustering and Classification

Monday, July 7, 3:30PM-6:00PM, Room: Posters Area (Level 2), Chair: Laszlo Szilagyi and Feng Wan

P101 *The SAR Image Segmentation Superpixel-Based with Optimized Spatial Information [#F-14013]*

Xiaolin Tian, Licheng Jiao, Yi Long and Xiaohua Zhang, Key Laboratory of Intelligent Perception and Image Understanding of Ministry of Education, International Research Center for Intelligent Perception and Computation, China

In this paper, we propose a method of image segmentation, which is based on superpixel and optimized spatial feature. In this paper, the superpixels are taken into account, which can reduce computational burden, and the result of over- segmentation can also be benefit for segmentation results. The main idea of this paper is based on the conventional fuzzy c-means (FCM). The conventional FCM has a better performance. However, it is sensitive to noise. In order to overcome this shortage, we incorporate spatial information of superpixels into the conventional FCM. In order to obtain the better performance, influential degree of spatial information is applied to the conventional FCM to improve segmentation performance Experimental results show that the proposed method achieves excellent performance.

P102 *Knowledge-Leverage Based TSK Fuzzy System with Improved Knowledge Transfer [#F-14039]*

Zhaohong Deng, Yizhang Jiang, Longbing Cao and Shitong Wang, Jiangnan University, China; University of Technology Sydney, Australia

In this study, the improved knowledge-leverage based TSK fuzzy system modeling method is proposed in order to overcome the weaknesses of the knowledge-leverage based TSK fuzzy system (TSK-FS) modeling method. In particular, two improved knowledge-leverage strategies have been introduced for the parameter learning of the antecedents and consequents of the TSK-FS constructed in the current scene by transfer learning from the reference scene, respectively. With the improved knowledge-leverage learning abilities, the proposed method has shown the more adaptive modeling effect compared with traditional TSK fuzzy modeling methods and some related methods on the synthetic and real world datasets.

P103 *Multiple-Kernel Based Soft Subspace Fuzzy Clustering [#F-14105]*

Jun Wang, Zhaohong Deng, Yizhang Jiang, Pengjiang Qian and Shitong Wang, Jiangnan University, China

Soft subspace fuzzy clustering algorithms have been successfully utilized for high dimensional data in recent studies. However, the existing works often utilize only one distance function to evaluate the similarity between data items along with each feature, which leads to performance degradation for some complex data sets. In this work, a novel soft subspace fuzzy clustering algorithm MKEWFC-K is proposed by extending the existing entropy weight soft subspace clustering algorithm with a multiple-kernel learning setting. By incorporating multiple- kernel learning strategy into the framework of soft subspace fuzzy clustering, MKEWFC-K can learning the distance function adaptively during the clustering process. Moreover, it is more immune to ineffective kernels and irrelevant features in soft subspace, which makes the choice of kernels less crucial. Experiments on real-world data demonstrate the effectiveness of the proposed MKEWFC-K algorithm.

P104 *Fast Color Reduction Using Approximative C-Means Clustering Models [#F-14174]*

Laszlo Szilagyi, Gellert Denesi and Sandor Miklos Szilagyi, Sapientia University of Transilvania, Romania; Petru Maior University of Tirgu Mures, Romania

In this paper we propose an efficient color reduction framework that employs c-means clustering to extract optimal colors. The processing consists of three stages: preprocessing, c-means clustering, and creation of the output image. The main goal of the first stage is to transform the pixel matrix into a list of records, which indicates what colors are present in the image and how many times they appear. To achieve this, first we apply a static color quantization scheme that aligns the 16.7 million possible colors with 140 thousand grid points, and build the histogram of this quantized image. Then we mark least frequent quantized colors to be ignored during the clustering stage, the amount of such marks being controlled by the pixel inclusion parameter. Leaving out 2-5% of the image pixels can reduce the number of colors to 500-5000 in most images. This limited set of colors together with frequency information consists the input of the c-means clustering process performed in the second stage. Before creating the final output image, the marked quantized colors are mapped to the closest cluster. Thorough numerical tests were performed on 500 randomly chosen images using both fuzzy and hard c-means clustering. Evaluations revealed that hard c-means is more suitable than fuzzy c-means for the given problem, both in terms of accuracy and efficiency. The proposed method performs quicker 2-3 times than other recent reported solutions.

P105 *A Fuzzy Clustering Algorithm with Robust Spatially Constraint for Brain MR Image Segmentation [#F-14176]*

Zexuan Ji, Guo Cao and Quansen Sun, Nanjing University of Science and Technology, China

Fuzzy clustering algorithms have been widely used in brain magnetic resonance (MR) image segmentation. However, due to the existence of noise and intensity inhomogeneity, many segmentation algorithms suffer from limited accuracy. In this paper, we propose a fuzzy clustering algorithm with robust spatially constraint for accurate and robust brain MR image segmentation. A novel spatial factor is proposed by incorporating the spatial information amongst neighborhood pixels with a simple metric. A new weight factor, which utilizes the intensity information of the original image, is constructed to filter the posterior and prior probabilities in the spatial neighborhood. The proposed method can preserve more details and overcome the over-smoothing disadvantage. Finally, the fuzzy objective function is integrated with the bias field estimation model to overcome the intensity inhomogeneity in the image and segment the brain MR images. Experimental results demonstrate that the proposed algorithm can substantially improve the accuracy of brain MR image segmentation.

P106 *Fuzzy C-Means Clustering with Weighted Energy Function in MRF for Image Segmentation [#F-14198]*

Chi Wang, Jia Liu, Maoguo Gong, Licheng Jiao and Jing Liu, Xidian University, China

In this paper, we present a new Markov Random Field based FCM image segmentation algorithm. A new energy function is proposed to utilize the spatial and contextual information simultaneously. In the proposed energy function, we use a weighted distance to reflect the different effects of neighborhood pixels. By using the new energy function, the new algorithm has a better performance in noise-corrupted images. Experimental results on real and synthetic images show our method is effective.

P107 *Fuzzy Clustering Using Local and Global Region Information for Cell Image Segmentation [#F-14280]*

Amin Gharipour and Alan Wee-Chung Liew, Griffith University, Australia

In high-throughput applications, accurate segmentation of biomedical images can be considered as an important step for recognizing cells that have the phenotype of interest. In this paper, while conventional fuzzy clustering is not able to implement the local and global spatial information, a novel spatial fuzzy clustering cell image segmentation algorithm is proposed. The segmentation procedure is divided into two stages: the first stage involves processing the local and global spatial information of the given cell image and a final segmentation stage which is based on the idea of conventional fuzzy clustering. Our idea can be considered as a sequential integration of region based methods and fuzzy clustering for cell image segmentation. Experimental results show that the proposed model yields significantly better performance in comparison with several existing methods.

P108 *A Method of Remote Sensing Image Auto Classification Based on Interval Type-2 Fuzzy C-Means [#F-14349]*

Xianchuan Yu, Wei Zhou and Hui He, Beijing Normal University, China; Beijing Normal University Zhuhai, China

The pattern set of a remote sensing image contains many kinds of uncertainties. Uncertain information can create imperfect expressions for pattern sets in various pattern recognition algorithms, such as clustering algorithms. Methods based the fuzzy c-means algorithm can manage some uncertainties. As soft clustering methods, They are known to perform better on auto classification of remote sensing images than hard clustering methods. However, if the clusters in a pattern set are of different density and high order uncertainty, performance of FCM may significantly vary depending on the choice of fuzzifiers. Thus, we cannot obtain satisfactory results by using type-1 fuzzy set. Type-2 fuzzy sets permit us to model various uncertainties which cannot be appropriately managed by type-1 fuzzy sets. This paper introduces the theory of interval type-2 fuzzy set into the unsupervised classification of remote sensing images and proposes the automatic remote sensing image classification method based on the interval type-2 fuzzy c-means. Experimental results indicate that our method can obtain more coherent clusters and more accurate boundaries from the data with density difference. Our type-2 fuzzy model can manage the uncertainties of remote sensing images more appropriately and get a more desirable result.

P109 *Color Image Segmentation Based on Decision-Theoretic Rough Set Model and Fuzzy C-Means Algorithm [#F-14356]*

Min Guo and Lin Shang, Nanjing University, China

This paper proposes an approach which combines the Decision Theoretic Rough Set model (DTRS) and Fuzzy CMeans(FCM) algorithm to perform color image segmentation. The FCM algorithm has the limitation that it requires the initialization of cluster centroids and the number of clusters. In this paper, the DTRS model is applied to color image segmentation for the purpose of clustering validity analysis which could overcome the defect of the FCM algorithm. Firstly, we adopt the Turbopixel algorithm to split the color image into many small regions called superpixels for presegmentation. Based on color image color histogram feature extraction we use Bhattacharyya coefficient to measure the similarity between superpixels, which is in preparation for clustering validity analysis. It is our focus that we will obtain cluster centroids and the number of clusters using FCM. Our approach is according to the hierarchical clustering validity analysis algorithm using DTRS model. Finally, the FCM algorithm is utilized to achieve the result of color image segmentation. Experimental results show that the DTRS-based preprocessing approach can obtain better segmentation results than other improved FCM approaches such as ant colony algorithm or histogram thresholding approach.

P110 *Fuzzy Clustering Algorithm with H-Operator Applied to Problems with Interval-based Data [#F-14478]*

Liliane Silva, Ronildo Moura, Anne Canuto, Regivan Santiago and Benjamin Bedregal, Federal University of Rio Grande do Norte, Brazil

The main advantage of using an interval-based distance for interval-based data lies on the fact that it preserves the underlying imprecision on intervals which is usually lost when real-valued distances are applied. One of the main problems when using interval-based distance in fuzzy clustering algorithms is the way to obtain the center of the groups. In this case, it is necessary to make adaptations in order to obtain those centers. Therefore, in this paper, we propose the use of the family of H-operator to proposed three approaches to transform the interval-based membership matrix into real- valued membership matrix and, as a consequence, to calculate the centers of the groups in interval-based fuzzy clustering algorithms. In this case, we will perform a comparative analysis using the three different approaches proposed in this paper, using seven interval-based datasets (four synthetic and three real datasets). As a result of this analysis, we will observe that the proposed approaches achieved better performance than all analyzed methods for interval-based methods.

P111 *A Novel Fuzzy Non-Homogeneity Measure Based Kernelized Image Segmentation for Noisy Images [#F-14487]*

Satrajit Mukherjee, Bodhisattwa Prasad Majumder, Aritran Piplai and Swagatam Das, Jadavpur University, India; Indian Statistical Institute, India

The paper proposes a novel non-homogeneity measure based kernelized image segmentation for noisy images. Every 3x3 neighbourhood of every single pixel is considered for generating localized spatial domain non-homogeneity measures for every individual window. Then these spatial domain non-homogeneity measures are converted into fuzzy domain non-homogeneity coefficients by aggregating the localized measures into a single distribution and then deriving fuzzy domain values from a Gaussian membership function. Quantitative analyses have been rendered with respect to state-of-the-art noisy-image segmentation techniques and results show improved performance. Speckle-noise ridden SAR images and Rician- noise ridden medical images are finally considered to show real-life applications of our algorithm.

P112 *A Novel Feature Measure for Fuzzy Clustering Algorithm on Microarray Data [#F-14209]*

Tian Yu and JinMao Wei, NanKai University, China

Fuzzy clustering algorithm is employed in gene microarray analysis to discover the strength of the association between genes and different clusters. Gene-based fuzzy clustering algorithm just employs all instances' values in a certain gene as this gene's features. In some sense, the original feature vector can hardly provide comprehensive discriminative information of the gene. In this paper, a novel feature vector by the proposed measure for each gene is employed in fuzzy clustering algorithm. The proposed feature vector can provide information about the influence of a given gene for the overall shape of clusters. By analysis and experiment upon microarray data sets, the performance of the fuzzy clustering algorithm based on proposed feature vector is compared with that of some classical clustering algorithms. The results demonstrate that the fuzzy clustering algorithm based on proposed feature vector is capable of obtaining better clusters than other contrast algorithms. The results by classifiers based on different clustering algorithms demonstrate that the proposed feature vector can get the same or better accuracy than the original feature vector.

P113 *Data-Based Fuzzy Rules Extraction Method for Classification [#F-14412]*

Xinyu Qiao, Zhenying Li, Wei Lu and Xiaodong Liu, Dalian University of Technology, China

In this study, a two-stage method which extracts fuzzy rules directly from samples is proposed for classification. First, we introduce a neighborhood based attribute significance algorithm to select r of the most important attributes from the original attribute set. Second, the proposed algorithm generates fuzzy rule from each sample described by the selected attribute subset and finally simplifies the returned fuzzy rule-base. A confidence degree is assigned for each of the extracted fuzzy rules by counting the number of training samples covered by the rule to solve the conflicts among the rules and then the rule-base is pruned. The performance of the proposed classification method have been compared with other five classification approaches including C4.5, DTable, OneR, NNge, and PART on seven UCI data sets. The experimental results show that the proposed method is better than other methods in two aspects: the higher classification accuracy and the smaller rule-base.

P114 *A Modified Fuzzy Co-Clustering (MFCC) Approach for Microarray Data Analysis [#F-14266]*
Sheng-Yao Huang, Hsing-Jen Sun, Chuen-Der Huang, I-Fang Chung and Chun-Hung Su, National Yang-Ming University, Taiwan; Hsiuping University of Science and Technology, Taiwan; Academia Sinica, Taiwan

Biologically a gene or a sample could participate in multiple biological pathways, and only few genes are concurrently involved in a cellular process under some specific experimental conditions. Hence, identification of a subset of genes showing similar regulations under subsets of condition in microarray data has become an important research issue. Many investigators develop bi-clustering methods to attack this problem. In this study, we adopt fuzzy co-clustering concept and design a procedure to iteratively extract bi-clusters with co- expressed gene patterns (here the entire proposed process is called a modified fuzzy co-clustering (MFCC) approach). We have applied synthetic data and compared our MFCC's performance with four well-known state-of-the-art methods. Here we have not only shown that our MFCC approach can successfully extract each designed bi-clusters in the synthetic data sets, but also have demonstrated the better performance by our MFCC approach.

Monday, July 7, 4:00PM-6:00PM

Special Session: MoF2-1 Fuzzy Decision-Making: Consensus and Missing Preferences II

Monday, July 7, 4:00PM-6:00PM, Room: 201A, Chair: Jian Wu and Enrique Herrera-Viedma

4:00PM *Consistency Based Estimation of Fuzzy Linguistic Preferences. The Case of Reciprocal Intuitionistic Fuzzy Preference Relations [#F-14054]*
Francisco Chiclana, Jian Wu and Enrique Herrera-Viedma, De Montfort University, United Kingdom; Zhejiang Normal University, China; University of Granada, Spain

The decision-making assumption of all experts being able to express their preferences on all available alternatives of a decision-making problem might be considered unrealistic. This is specially true when the number of alternatives is considerable high and/or when sources of information are conflicting and dynamic. Thus, the presence of incomplete information, which is not equivalent to low quality information, is worth investigation and its processing within decision-making processes desirable. A consistency based approach to deal with incomplete fuzzy linguistic preferences is the focus of this contribution. Consistency is considered here as linked to the transitivity of preferences, and in particular to Tanino's multiplicative transitivity property of reciprocal fuzzy preference relations. The first result presented is the formal modelling and representation of Tanino's multiplicative transitivity property to the case of fuzzy linguistic preference relations. This is done via Zadeh's extension principle and the representation theorem of fuzzy sets. The second result derives the multiplicative transitivity property of reciprocal intuitionistic fuzzy preference relations, which can be isomorphically mapped to a particular type of linguistic preference relation: reciprocal interval-valued fuzzy preference relations. The third result is the computation of the consistency based estimated reciprocal intuitionistic fuzzy preference values using an indirect chain of alternatives, which can be used to address incomplete information in decision-making problems with this type of preference relations.

4:20PM *A Revised Procedure to Estimate Missing Values in Incomplete Fuzzy Preference Relations [#F-14046]*
Yejun Xu, Feng Ma and Huimin Wang, Hohai University, China; Hohai Universty, China

In this paper, we propose a four-way procedure to estimate missing preference values when dealing with acceptable incomplete fuzzy preference relations (IFPRs). The proposed revised procedure can estimate more missing elements in the first iteration and also has more advantages than the existing methods. An illustrative example and comparative analyses are offered to demonstrate the advantages of the proposed method.

4:40PM *A Method for Estimating Criteria Weights from Interval-Valued Intuitionistic Fuzzy Preference Relation [#F-14294]*
Weize Wang, Xinwang Liu and Jindong Qin, Guangxi Normal University, China; Southeast University, China

Interval-valued intuitionistic fuzzy preference relation is a useful tool to express decision maker's interval-valued intuitionistic fuzzy preference information over criteria in the process of multi-criteria decision making. How to derive the priority weights from an interval-valued intuitionistic fuzzy preference relation is an interesting and important issue in decision making with interval-valued intuitionistic fuzzy preference relation(s). In this paper, some new concepts such as interval-valued interval fuzzy sets, interval-valued interval fuzzy preference relation and consistent interval-valued intuitionistic fuzzy preference relation, are defined, and the equivalent interval-valued interval fuzzy preference relation of interval-valued intuitionistic fuzzy preference relation is given. Then a method for estimating criteria weights from interval- valued intuitionistic fuzzy preference relations is developed, two numerical examples are provided to illustrate the developed method.

5:00PM *A New Fuzzy Ranking Method Using Fuzzy Preference Relations [#F-14131]*
Kok Chin Chai, Kai Meng Tay and Chee Peng Lim, Universiti Malaysia Sarawak, Malaysia; Deakin University, Australia

In this paper, a new fuzzy ranking method for both type-1 and interval type-2 fuzzy sets (FSs) using fuzzy preference relations is proposed. The use of fuzzy preference relations to rank FSs with vertices has been introduced, and successfully implemented to undertake fuzzy multiple criteria hierarchical group decision-making problems. The proposed fuzzy ranking method is an extension of the results published, and it is able to rank FSs with and without vertices. Besides that, it is important for a fuzzy ranking method to satisfy six reasonable fuzzy ordering properties as discussed. As a result, the capability of the proposed fuzzy ranking method in fulfilling these properties is analyzed and discussed. Issues related to time complexity of the proposed method are also examined.

5:20PM *Averaging Aggregation Functions for Preferences Expressed as Pythagorean Membership Grades and Fuzzy Orthopairs [#F-14115]*
Gleb Beliakov and Simon James, Deakin University, Australia

Rather than denoting fuzzy membership with a single value, orthopairs such as Atanassov's intuitionistic membership and non-membership pairs allow the incorporation of uncertainty, as well as positive and negative aspects when providing evaluations in fuzzy decision making problems. Such

representations, along with interval-valued fuzzy values and the recently introduced Pythagorean membership grades, present particular challenges when it comes to defining orders and constructing aggregation functions that behave consistently when summarizing evaluations over multiple criteria or experts. In this paper we consider the aggregation of pairwise preferences denoted by membership and non-membership pairs. We look at how mappings from the space of Atanassov orthopairs to more general classes of fuzzy orthopairs can be used to help define averaging aggregation functions in these new settings. In particular, we focus on how the notion of `averaging' should be treated in the case of Yager's Pythagorean membership grades and how to ensure that such functions produce outputs consistent with the case of ordinary fuzzy membership degrees.

5:40PM *Interval Type-2 Relational Analysis and Its Application to Multiple Attribute Decision Making [#F-14057]*

Jindong Qin and Xinwang Liu, Southeast University, China

In this paper, we present the interval type-2 fuzzy rational degree to measure the similarity of the interval type-2 fuzzy sets and apply it to multiple attribute decision making with interval type-2 fuzzy information. First, we introduce the concept of the interval type-2 fuzzy metric spaces, which include interval type-2 fuzzy distance space and interval type-2 fuzzy inner product space. Based on which, we derive the distance measure and inner product of interval type-2 fuzzy sets, respectively. Then, we introduce the axiomatic definition of the interval type-2 fuzzy rational degree and propose an interval type-2 fuzzy rational degree formula. Moreover, we construct the mathematical optimal model based on two types of interval type-2 fuzzy measures (center of gravity and fuzziness) to determine the optimal attribute weights. Based on the interval type-2 fuzzy rational degree and the optimal weights solution model we proposed, an approach to multiple attribute decision making under interval type-2 fuzzy environment is developed. Finally, an illustrative example is given to demonstrate the practicality and effectiveness of our method.

Special Session: MoF2-2 Fuzzy Systems on Renewable Energy

Monday, July 7, 4:00PM-6:00PM, Room: 201B, Chair: Faa-Jeng Lin and Francesco Grimaccia

4:00PM *Intelligent Controlled Three-Phase Squirrel-Cage Induction Generator System Using Hybrid Wavelet Fuzzy Neural Network [#F-14036]*

Faa-Jeng Lin and Jin-Kuan Chang, National Central University,, Taiwan; National Central University, Taiwan

An intelligent controlled three-phase squirrel-cage induction generator (SCIG) system for grid-connected wind power applications using hybrid wavelet fuzzy neural network (WFNN) is proposed in this study. First, the indirect field- oriented mechanism is implemented for the control of the SCIG system. Then, an AC/DC power converter and a DC/AC power inverter are developed to convert the electric power generated by a three-phase SCIG to power grid. Moreover, the dynamic model of the SCIG system and an ideal computed torque controller are developed for the control of the square of DC-link voltage. Furthermore, an intelligent hybrid WFNN controller and two WFNN controllers, which are computation intensive approaches, are proposed for the AC/DC power converter and the DC/AC power inverter respectively to improve the transient and steady- state responses of the SCIG system at different operating conditions. In the intelligent hybrid WFNN controller, to relax the requirement of the lumped uncertainty in the design of the ideal computed torque controller, a WFNN is designed as an uncertainty observer to adapt the lumped uncertainty online. Finally, the feasibility and effectiveness of the SCIG system for grid- connected wind power applications is verified with experimental results.

4:20PM *Adaptive Unscented Kalman Filter with a Fuzzy Supervisor for Electrified Drive Train Tractors [#F-14019]*

Pavel Osinenko, Mike Geissler and Thomas Herlitzius, Technische Universitaet Dresden, Germany

Electrified drive trains for tractors are supposed to realize great potential of raising performance in heavy operations via optimal traction control. The paper proposes to apply an adaptive unscented Kalman filter (UKF) with a fuzzy supervisor for identification of electrical drive train tractor dynamics. The key advantage of electrical drive trains lies in feedback of drive torque which plays crucial role in traction parameter estimation. It is known that without using special adaptation techniques, an UKF may cause some divergence problems and lowered precision of estimation as well as its predecessor, an extended Kalman filter (EKF). A method based on a fuzzy logic supervisor in addition to adaptation of an UKF is proposed to maintain trade-off between tracking strength and estimation accuracy. Simulation results with a comprehensive tractor dynamics model showed increase in estimation precision of traction parameters. Laboratory experiments using a test stand with an electrical load machine showed appropriate estimation of the load torque

4:40PM *Improving LVRT Characteristics in Variable-Speed Wind Power Generation by Means of Fuzzy Logic [#F-14370]*

Minh Quan Duong, Francesco Grimaccia, Sonia Leva, Marco Mussetta and Riccardo E. Zich, Politecnico di Milano, Italy

Wind system using a fixed-speed wind power generation SCIG (Squirrel-cage Induction Generator) tends to drain large amount of reactive power from the grid, potentially causing a drop voltage and perhaps voltage stability conundrum. To improve the SCIG's low voltage ride through (LVRT) characteristics, this paper presents a new control strategy for a variable-speed wind power generation DFIG (Doubly-fed Induction Generator) located closely to the SCIG-based wind system by utilizing the control capability of fuzzy logic technique. The proposed control system regulates effectively reactive power output of the DFIG wind turbine by controlling both grid-side and rotor-side converters to compensate the reactive power absorbed by the SCIG-based wind turbine. The effectiveness of the proposed control strategies is proven by simulation results. These illustrates that the LVRT characteristics and stability margin of the SCIG-based wind system is significantly improved when extra reactive power is compensated from the DFIG wind system in the proximity.

5:00PM *A Heuristic Fuzzy Algorithm Bio-Inspired by Evolution Strategies for Energy Forecasting Problems [#F-14400]*

Vitor N. Coelho, Frederico G. Guimaraes, Agnaldo J. R. Reis, Igor M. Coelho, Bruno N. Coelho and Marcone J. F. Souza, Universidade Federal de Minas Gerais, Brazil; Universidade Federal de Ouro Preto, Brazil; Universidade Federal Fluminense, Brazil

Improving the use of energy resources has been a great challenge in the last years. A new complex scenario involving a decentralized bidirectional communication between energy suppliers, distribution system and consumption is nowadays becoming reality. Sometimes cited as the largest and most complex machine ever built, Electric Grids (EG) are been transformed into Smart Grids (SG). Hence, the load forecasting problem has become more difficulty and more autonomous load predictors are needed in this new conjecture. In this paper a novel method, so-called MSES, bio-inspired by Evolution Strategies (ES) combined with Multi-Start (MS) procedure is described. This procedure is mainly based on a self-adaptive algorithm to calibrate the parameters of the fuzzy rules. MSES was implemented in C++ via OptFrame framework. Our main goal is to evaluate the performance of this algorithm in a grid environment. Real data from an electric utility have been used in order to test the proposed methodology. The obtained results are fully described and analyzed.

5:20PM *Optimal Fuzzy Logic Based Coordination Controller for Improved Transient Stability of a Smart Grid [#F-14451]*

Ganesh Kumar Venayagamoorthy and Priyam Chakravarty, Clemson University, United States; the Structure Group, United States

While smart grid disturbances are inevitable, their effects can be minimized through intelligent power management and control. SmartParks (large numbers of electric vehicles capable of performing bidirectional power transactions) or energy storage systems can be used to improve the transient stability of a smart grid with wind farms when faults are experienced. In this paper, the speed oscillations in conventional generators are minimized by optimizing a fuzzy logic controller performing coordinated control between SmartParks and a wind farm. A novel heuristic search based algorithm, mean variance optimization, is applied for the optimization tasks. The results demonstrate the improvement in the overall transient stability of the system operating under disturbances at different locations in the system.

5:40PM *Design and Implementation of Power Electronic Load Used to Test Tidal Current Energy Generator Sets [#F-14339]*

Shenghui Wang, Ming Li, Zhen Chen, Guanghong Chang, Jianguo Wang and Shiqi An, Ocean University of China, China; Qingdao University of Science and Technology, China

Tidal current energy receives increasing interest as a green renewable energy. Power electronic load is a useful tool to test and evaluate the performance of tidal current energy generator sets. In this paper, a novel power electronic load scheme is proposed. There are four control mode, such as constant power, constant voltage, constant current and constant resistance. It is flexible and can be used to evaluate the power parameters, realize the Maximum Power Point Tracking etc.. An three-stage load control technology is applied to improves the system response speed and control precision. The controller is developed based on STM32. The core control algorithm is Generalized Fuzzy Hyperbolic Model (GFHM) PID algorithm. The real time data may be monitored remotely via GPRS. The simulation and field testing results verified the significations of this scheme. Some valuable experience and data are obtained, and indicate that it is very useful for the further investigate tidal current energy power generation.

MoF2-3 Evolving & Adaptive Fuzzy Systems

Monday, July 7, 4:00PM-6:00PM, Room: 201C, Chair: Plamen Angelov and Pablo Estevez

4:00PM *Adaptive T-S Fuzzy Sliding Mode Control of MEMS Gyroscope [#F-14004]*

Yunmei Fang, Shitao Wang and Juntao Fei, Hohai University, China

In this paper, a MIMO Takagi-Sugeno (T-S) fuzzy model is built on the basis of the nonlinear model of micro -electro mechanical system (MEMS) gyroscope. A robust adaptive sliding mode control with on-line identification for the upper bounds of external disturbance and estimator for the model uncertainty parameters is proposed. Based on Lyapunov methods, these adaptive laws can guarantee that the system is asymptotically stable, and force the proof mass of the MEMS gyroscope to oscillate in the x and y direction at given frequency and amplitude. The controller is implemented on the nonlinear model of MEMS gyroscope at the same time. Numerical simulations are investigated to verify the effectiveness of the proposed control scheme on the T-S model and the nonlinear model.

4:20PM *Fuzzy Adaptive Decentralized Control for Switched Nonlinear Large-Scale Systems Based on Backstepping Technique [#F-14032]*

Yongming Li, Shaocheng Tong and Tieshan Li, Liaoning University of Technology, China; Dalian Maritime University, China

In this paper, the problem of fuzzy adaptive state feedback control is investigated for a class of switched uncertain nonlinear large-scale systems. There exist switching jumps and uncertainties in systems models and switching signals, respectively. Fuzzy logic systems are utilized to approximate the unknown nonlinear functions, and combining the adaptive backstepping technique and the dwell-time property of the switching signal, an adaptive fuzzy state- feedback control approach is developed. It is proved that the proposed control approach can guarantee that all the signals in the closed-loop system are bounded, and the tracking errors converge to a small neighborhood of the origin.

4:40PM *A Novel Meta-Cognitive-based Scaffolding Classifier to Sequential Non-stationary Classification Problems [#F-14058]*

Mahardhika Pratama, Meng Joo Er, Sreenatha Anavatti, Edwin Lughofer, Ning Wang and Imam Arifin, The University of New South Wales, Australia; Nanyang Technological University, Singapore; Johannes Kepler University, Austria; Dalian Maritime University, China; Institute Teknologi Sepuluh Nopember, Indonesia

a novel meta-cognitive-based scaffolding classifier, namely Generic-Classifier (gClass), is proposed in this paper to handle non-stationary classification problems in the single-pass learning mode. Meta-cognitive learning is a breakthrough in the machine learning where the learning process is not only directed to craft learning strategies to exacerbate the classification rates , i.e., how-to-learn aspect, but also is focused to accommodate the emotional reasoning and commonsense of human being in terms of what-to-learn and when-to- learn facets. The crux of gClass is to synergize the scaffolding learning concept, which constitutes a well-known tutoring theory in the psychological literatures, in the how-to-learn context of meta-cognitive learning, in order to boost the learner's performance in dealing with complex data. A comprehensive empirical studies in time-varying datasets is carried out, where gClass numerical results are benchmarked with other state-of-the-art classifiers. gClass is, generally speaking, capable of delivering the most encouraging numerical results where a trade-off between predictive accuracy and classifier's complexity can be achieved.

5:00PM *Adaptive Robust Tracking Control of Surface Vessels Using Dynamic Constructive Fuzzy Neural Networks [#F-14291]*

Ning Wang, Bijun Dai, Yancheng Liu and Min Han, Dalian Maritime University, China; China CNR Corporation Limited, China; Dalian University of Technology, China

In this paper, an adaptive robust dynamic constructive fuzzy neural control (AR-DCFNC) scheme for trajectory tracking of a surface vehicle with uncertainties and unknown time-varying disturbances is proposed. System uncertainties and unknown dynamics are identified online by a dynamic constructive fuzzy neural network (DCFNN) which is implemented by employing dynamically constructive fuzzy rules according to the structure learning criteria. The entire AR-DCFNC system is globally asymptotical stable.

5:20PM *Dynamically Evolving Fuzzy Classifier for Real-Time Classification of Data Streams [#F-14348]*

Rashmi Dutta Baruah, Plamen Angelov and Diganta Baruah, Sikkim Manipal Institute of Technology, India; Lancaster University, United Kingdom

In this paper, a novel evolving fuzzy rule-based classifier is presented. The proposed classifier addresses the three fundamental issues of data stream learning, viz., computational efficiency in terms of processing time and memory requirements, adaptive to changes, and robustness to noise. Though, there are several online classifiers available, most of them do not take into account all the three issues simultaneously. The newly proposed classifier is inherently adaptive and can attend to any minute changes as it learns the rules in online manner by considering each incoming example. However, it should be emphasized that it can easily distinguish noise from new concepts and automatically handles noise. The performance of the classifier is evaluated using real-life data with evolving characteristic and compared with state-of-the-art adaptive classifiers. The experimental results show that the classifier attains a simple model in terms of number of rules. Further, the memory requirements and processing time per sample does not increase linearly with the progress of the stream. Thus, the classifier is capable of performing both prediction and model update in real- time in a streaming environment.

5:40PM *Globally Fuzzy Model Based Adaptive Variable Structure Control for a Class of Nonlinear Time-Varying Systems [#F-14355]*

Chih-Lyang Hwang, National Taiwan University of Science and Technology, Taiwan

In this paper, a nonlinear time-varying dynamic system is first approximated by N fuzzy-based linear state-space subsystems. To track a trajectory dominant by a specific frequency, the reference models with desired amplitude and phase features are established by the same fuzzy sets of the system rule. It is known that linear state feedback control for each fuzzy subsystem is inferior to that using nonlinear feedback control. It is also known that most of the fuzzy adaptive controls must be in a specific domain for the function approximation. To overcome the above shortcomings, we propose a globally fuzzy model based adaptive variable structure control with a switching function to determine when the learning law should be used. As the norm of the switching surface is inside of a defined set, the learning law starts; simultaneously, as it is outside of the other set which is larger than the previous defined set, the learning law stops. In this situation, the proposed control is verified to converge into a convex set, which is smaller than the set for the function approximation. For the purpose of smoothing the possibility of discontinuous control input, a transition between outside and inside of approximated set is also assigned. Under the circumstances, the proposed control can automatically tune as a control without and with the learning compensation of uncertainties. Finally, the stability of the overall system is verified by Lyapunov stability theory.

6:00PM *Optimized Fuzzy Association Rule Mining for Quantitative Data [#F-14315]*

Hui Zheng, Jing He, Guangyan Huang and Yanchun Zhang, University of Chinese Academy of Science, China; Victoria University, Australia

With the advance of computing and electronic technology, quantitative data, for example, continuous data (i.e., sequences of floating point numbers), become vital and have wide applications, such as for analysis of sensor data streams and financial data streams. However, existing association rule mining generally discover association rules from discrete variables, such as boolean data ('0' and '1') and categorical data ('sunny', 'cloudy', 'rainy', etc.) but very few deal with quantitative data. In this paper, a novel optimized fuzzy association rule mining (OFARM) method is proposed to mine association rules from quantitative data. The advantages of the proposed algorithm are in three folds: 1) propose a novel method to add the smoothness and flexibility of membership function for fuzzy sets; and 2) optimize the fuzzy sets and their partition points with multiple objective functions after categorizing the quantitative data; 3) design a two-level iteration to filter frequent-item-sets and fuzzy association-rules. The new method is verified by three different data sets, and the results have demonstrated the effectiveness and potentials of the developed scheme.

MoF2-4 Fuzzy Logic and Fuzzy Set Theory II

Monday, July 7, 4:00PM-6:00PM, Room: 201D, Chair: Janos Grantner and Jian Wu

4:00PM *On the Alpha-Universal Multiple I Restriction Method for General Fuzzy Reasoning [#F-14178]*

Yiming Tang and Xiaomei Li, Hefei University of Technology, China

Based on the differently implicational idea, the alpha-universal multiple I restriction method is put forward for general fuzzy reasoning, which contains the alpha-multiple I restriction method as its specific case. First of all, we give the alpha-universal multiple I restriction principle, which improves the previous restriction principle, and then provide the existing condition of the solutions of the new method. Furthermore, we obtain the optimal solution of the new method for the fuzzy implications with residual pair, the R-implications, as well as some particular fuzzy implications. Finally, it is found that the new method is more reasonable by contrast with the alpha-multiple I restriction method.

4:20PM *The Properties and Information Measures for Information Sets [#F-14230]*

Manish Agarwal, Madasu Hanmandlu and Kanad Biswas, Indian Institute of Technology Delhi, India

Information sets expand the scope of the existing uncertainty theories by representing uncertainty in the information sources. An information set takes into account both the information source values as well as the membership grades. In this study, we investigate in detail the properties of the information sets. The information measures for the information sets are also developed to measure the information content in an information set.

4:40PM *FTFBE: A Numerical Approximation for Fuzzy Time-Fractional Bloch Equation [#F-14252]*

Ali Ahmadian, Chee Seng Chan, Soheil Salahshour and Vembarasan Vaitheeswaran, University of Malaya, Malaysia; Islamic Azad University, Iran

Fractional calculus has a long successful history of 300 years, as it able to model natural phenomena states more accurately than the differential equations of integer order. With this, it plays an important role in variant disciplines. Recently, variant fractional models for the Bloch equations have been proposed, however, effective numerical methods for the fractional Bloch equation (FBE) are still in the infancy stage. In this paper, we extend the time-fractional Bloch equation (TFBE) to fuzzy field under the generalized Caputo differentiability, such that these extensions have natural relationship between crisp. For this purpose, we adopted the fractional Adams-Bashforth-Moulton (FABM) type predictor-corrector method, and introduced a new variant - the fuzzy fractional ADM (FFABM) to find the numerical solution. In this case, a new theorem concerning the error of our proposed FFADM method is also presented. Finally, the capability of the newly developed numerical methods is demonstrated in a fuzzy fractional-order problem, and it achieves satisfactorily in terms of numerical stability.

5:00PM *A Fuzzy Logic Based Bargaining Model in Discrete Domains: Axiom, Elicitation and Property [#F-14376]*

Jieyu Zhan, Xudong Luo, Cong Feng and Wenjun Ma, Sun Yat-sen University, China; Queen's University, United Kingdom

This paper builds a multi-demand bargaining model based on fuzzy rules, and introduces its agreement concept, which satisfies four intuitive properties of consistency, collective rationality, disagreement and minimum concession. In the model, the fuzzy rules are used to calculate how much bargainers should change their preference during a bargaining. Moreover, the psychological experiment are used to elicit the fuzzy rules. In addition, we analyse how bargainers' risk attitude, patience and regret degree influence agreement of our bargaining game, and identify the existence conditions of bargaining agreement.

5:20PM *From Data to Granular Data and Granular Classifiers [#F-14111]*

Rami Al-Hmouz, Pedrycz Witold, Belamash Abdulla and Morfeq Ali, King Abdulaziz University, Saudi Arabia; University of Alberta, Canada; King Abdulaziz Univesity, Saudi Arabia

Information granules emerging as a result of an abstract and more condensed view at numeric data play an essential role in various pattern recognition pursuits. In this study, we investigate an idea of granular prototypes (representatives) and discuss their role in the realization of classification schemes. A two-stage procedure of a formation of information granules is discussed. We show how the commonly used clustering methods are viewed as a prerequisite for the construction of granular prototypes. In this regard, a certain version of the principle of justifiable granularity is investigated. In the sequel, a characterization of information granules expressed in terms of their information (classification) content is provided and its usage in the realization of a classifier is studied. Experimental studies involving both synthetic and publicly available data are reported.

5:40PM *Positive Definite Kernel Functions on Fuzzy Sets [#F-14155]*

Jorge Guevara Diaz, Roberto Hirata Jr and Stephane Canu, University of Sao Paulo, Brazil; INSA de Rouen, France

Embedding non-vectorial data into a vector space is very common in machine learning, aiming to perform tasks such as classification, regression or clustering. Fuzzy datasets or datasets whose observations are fuzzy sets, are examples of non-vectorial data and, several fuzzy pattern recognition algorithms analyze them in the space formed by the set of fuzzy sets. However, the analysis of fuzzy data in such space has the limitation of not being a vector space. To overcome such limitation, we propose the embedding of fuzzy data into a proper Hilbert space of functions called the Reproducing Kernel Hilbert Space (RKHS). This embedding is possible by using a positive definite kernel function on fuzzy sets. We present a formulation of a real-valued kernels on fuzzy sets, in particular, we define the intersection kernel and the cross product kernel on fuzzy sets giving some examples of them using T-norm operators. Also, we analyze the nonsingleton TSK fuzzy kernel and, finally, we give some examples of kernels on fuzzy sets that can be easily constructed from the previous ones.

Tuesday, July 8, 1:30PM-3:30PM

Special Session: TuF1-1 Computing with Words in Decision Making

Tuesday, July 8, 1:30PM-3:30PM, Room: 201A, Chair: Francisco Herrera and Luis Martinez

1:30PM *A Distance Based Ranking Methods for Type-1 Fuzzy Numbers and Interval Type-2 Fuzzy Numbers [#F-14061]*

Xiuzhi Sang, Xinwang Liu and Mei Cai, Southeast University, China; Nanjing University of Information Science and Technology, China

Although there are many methods for ranking type-1 fuzzy numbers, most of which exist some limitations. In this paper, we firstly propose a new distance measure based method to rank type-1 fuzzy numbers, which defines two formats of possibility mean and variation coefficient. It not only clearly discriminates the ranking of the type-1 fuzzy numbers especially for the reasonable ranking of symmetric type-1 fuzzy numbers, but also satisfies the consistence of the ranking with their images. Then, we extend such distance method to the ranking interval type-2 fuzzy numbers. For ranking both the type-1 fuzzy numbers and interval type-2 fuzzy numbers, the proposed methods are easy to understand and their computations are simple. Several typical examples are used to illustrate our new ranking methods for type-1 fuzzy numbers and interval type-2 fuzzy numbers.

1:50PM *Connecting the Numerical Scale Model to the Unbalanced Linguistic Term Sets [#F-14128]*

Yucheng Dong, CongCong Li and Herrera Francisco, Sichuan University, China; University of Granada, Spain

Herrera and Martinez initiated a 2-tuple linguistic representation model for computing with words (CWW). In addition to the Herrera and Mart\'{i}nez model, two different models based on linguistic 2-tuples (i.e., the model of Herrera et al. and the numerical scale model) have been developed to deal with term sets that are not uniformly and symmetrically distributed, i.e., unbalanced linguistic term sets (ULTSs). Both the model of Herrera et al. and the numerical scale model can deal with ULTSs, so a challenge is naturally proposed to analysts: how to compare these two different models. In this study, we provide a connection between the model of Herrera et al. and the numerical scale model. The results show that the model of Herrera et al.

provides a new approach to set a numerical scale. Furthermore, we show the equivalence (in some sense) of the linguistic computational models between the model of Herrera et al. and the numerical scale model, if the numerical scale is set based on the model of Herrera et al.

2:10PM *New Linguistic Aggregation Operators for Decision Making [#F-14229]*

Manish Agarwal, Madasu Hanmandlu and Kanad Biswas, Indian Institute of Technology Delhi, India

This paper presents new operators named as linguistic reweighted arithmetic averaging (LRAA) and linguistic reweighted geometric averaging (LRGA) to aggregate the information in group multi criteria decision making problems under the linguistic settings. These operators are equipped with a capacity to deduce weights of the criteria commensurate with their ability to discriminate the alternatives. The properties of the operators are given. The proposed concepts are illustrated through a case study of group multi criteria decision making.

2:30PM *A Consensus and Maximizing Deviation Based Approach for Multi-Criteria Group Decision Making under Linguistic Setting [#F-14287]*

Zhibin Wu and Yunfei Fang, Sichuan University, China; Fuzhou University, China

In practical group decision making (GDM) problems adhere to uncertain and imprecise data, the experts may express their preferences using linguistic terms. The aim of this paper is to present a method to assist the consensus process and selection process of multi-criteria GDM (MCGDM) problem under linguistic setting. If the consensus level does not meet predefined requirements, an algorithm is provided to help the decision maker or moderator reach the consensus goal. Once the consensus reaching process is finished, the maximizing deviation method is used to derive the importance weights of the attributes. Then, the linguistic weighted arithmetic averaging (LWAA) operator of 2-tuple linguistic variables is used to obtain the overall assessment value of each alternative and the ranking order of all alternatives can be determined. Finally, one example of personal selection problem is given to show the use of the proposed method.

2:50PM *An Approach Based on Computing with Words to Manage Experts Behavior in Consensus Reaching Processes with Large Groups [#F-14366]*

Ivan Palomares, Francisco J. Quesada and Luis Martinez, University of Jaen, Spain

Group decision making problems are characterized by the participation of multiple experts with different points of view, who attempt to find a common solution to a problem composed by a set of alternatives. Such problems are often defined in environments of uncertainty caused by the imprecision and vagueness of information, therefore experts must utilize appropriate information domains to deal with such uncertainty when expressing their preferences, e.g. linguistic information. Usually, in group decision making problems it is necessary to apply a consensus reaching process, in which experts discuss and make their opinions closer to each other, in order to achieve a high level of agreement before making the decision. Nevertheless, in large-scale group decision making problems, where a large group of individuals take part, it is more frequent the existence of certain subgroups with a non-cooperative behavior towards consensus reaching. For this reason, it would be convenient to identify such subgroups and deal with them, so that their behavior does not affect the consensus reaching process negatively. In this contribution, we present an approach based on computing with words and fuzzy set theory, to study the behavior of experts in consensus reaching processes, with the aim of identifying and penalizing the importance weights of those experts whose behavior does not contribute to reach a collective agreement.

3:10PM *An Approach of Decision Making with Linguistic Weight [#F-14410]*

Li Zou, Yunxia Zhang, Zhiyan Chang and Yong Zhang, Liaoning Normal University, China; Tianjin University of Technology, China

In the reality, people use linguistic term rather than numerical information to express their evaluations or preferences in decision making problems. To deal with the qualitative information, we propose a linguistic decision making approach based on the ten-element linguistic-valued lattice implication algebra. In this paper, we discuss the properties of two important operations, i.e. and , in ten-element linguistic lattice implication algebra. In the decision making approach proposed in this paper, we use the operation to calculate the weighted criteria in view of its properties. The illustration example shows that the proposed approach seems more effective for decision making under a fuzzy environment with both comparable and incomparable linguistic truth values.

Special Session: TuF1-2 Time Series: Advanced Methods of Analysis and Forecast

Tuesday, July 8, 1:30PM-3:30PM, Room: 201B, Chair: Irina Perfilieva and Jin Hee Yoon

1:30PM *A Proposal for the Hierarchical Segmentation of Time Series: Application to Trend-Based Linguistic Description [#F-14470]*

Rita Castillo-Ortega, Nicolas Marin, Carmen Martinez-Cruz and Daniel Sanchez, University of Granada, Spain; University of Jaen, Spain

In this paper we propose methods for obtaining hierarchical segmentations of time series on the basis of the Iterative End-Point Fit Algorithm. We discuss on the utility of the methods for different cases. We illustrate the usefulness of the hierarchical segmentations with an application in linguistic description of trends in time series. A linguistic description based on a segmentation of the time series that do not necessarily corresponds to a level of the hierarchy is obtained by describing segments in different levels that form a segmentation satisfying a quality model.

1:50PM *Non-linear Variable Structure Regression (VSR) and Its Application in Time-Series Forecasting [#F-14042]*

Mohammad Korjani and Jerry Mendel, University of Southern California, United States

Variable Structure Regression (VSR) is a new kind of non-linear regression model, which simultaneously determines the exact mathematical structure of non-linear regressors and how many regressors there are, thereby freeing the end user from trial and error time-consuming studies to determine these. The results are based on an iterative procedure for optimizing parameters and automatically identifying the structure of the VSR model. A novel feature of this new model is it not only uses a linguistic term for a variable but it also uses the complement of that term. It also provides the end user with a physical understanding of the regressors. A Monte Carlo study shows the practical accuracy of VSR model on the classical Gas Furnace time-series prediction problem. VSR ranked 1 compared to five other methods.

2:10PM *Fuzzy Rule-Based Ensemble for Time Series Prediction: The Application of Linguistic Associations Mining [#F-14218]*

Martin Stepnicka, Lenka Stepnickova and Michal Burda, University of Ostrava, Czech Republic

As there are many various methods for time series prediction developed but none of them generally outperforms all the others, there always exists a danger of choosing a method that is inappropriate for a given time series. To overcome such a problem, distinct ensemble techniques, that combine more individual forecasts, are being proposed. In this contribution, we employ the so called fuzzy rule-based ensemble. This method is constructed as a linear combination of a small number of forecasting methods where the weights of the combination are determined by fuzzy rule bases based on time series features such as trend, seasonality, or stationarity. For identification of fuzzy rule base, we use linguistic association mining. An exhaustive experimental justification is provided.

2:30PM *Forecasting Using F-Transform Based on Bootstrap Technique [#F-14346]*

Woo Joo Lee, Hye Young Jung, Jin Hee Yoon and Seung Hoe Choi, Yonsei University, Korea (South); Sejong University, Korea (South); Korea Aerospace University, Korea (South)

A new modified Fuzzy transform (F-transform) method which is combined with the bootstrap technique for forecasting is proposed in this paper. We apply the bootstrap technique to improve the accuracy of the F-transform method. An example is given to show the superior of proposed method.

2:50PM *Time Series Grouping on the Basis of F^1-Transform [#F-14259]*

Anton Romanov, Irina Perfilieva and Nadezhda Yarushkina, TU Ulyanovsk, Russia; University of Ostrava, Czech Republic

The contribution is focused on a new method of grouping time series according to their local tendency indicator that is expressed by a linear coefficient of the F^1-transform. The useful consequence of grouping is an effective procedure of forecasting such that only one time series from a group is forecasted.

3:10PM *Trust Prediction Using Z-Numbers and Artificial Neural Networks [#F-14123]*

Ali Azadeh, Reza Kokabi, Morteza Saberi, Farookh Khadeer Hussain and Omar Khadeer Hussain, University of Tehran, Iran; Tafresh University, Iran; University of Technology Sydney, Australia; University of New South Wales, Australia

Trust modeling of both the interacting parties in a virtual world, is a critical element of business intelligence. A key aspect in trust modeling is to be able to accurately predict the future trust value of an interacting party. In this paper, we propose an intelligent method for predicting the future trust value of a trusted entity. We propose the use of Z-number to represent both the trust value and its corresponding reliability. Subsequently, we apply Artificial Neural Network (ANN) to predict future trust values. We generate a large number of synthetic time series, with a view to model real-world trust values of trusted entity. We validate the working of our methodology using the generated time series.

Special Session: TuF1-3 Fuzzy Computer Vision and Biometrics

Tuesday, July 8, 1:30PM-3:30PM, Room: 201C, Chair: Chee Seng Chan

1:30PM *Moving Vehicle Detection Based on Fuzzy Background Subtraction [#F-14089]*

Xiaofeng Lu, Takashi Izumi, Tomoaki Takahashi and Lei Wang, Nihon University, Japan; Xi'an University of Technology, China

Background subtraction is a method typically used to segment moving regions in image sequences taken from a static camera by comparing each new frame with a model of the background scene. This paper proposes a novel fuzzy background subtraction algorithm for moving vehicle detection which achieves the high detection rates, and reduces the influence of illumination changes and shadows in the traffic scene. The proposed method adopts the Choquet integral for fusion the similarity measures of three color components of the YCbCr color space and uniform local binary pattern texture. Otherwise, an adaptive selective method for background maintenance is proposed to address the problem of background pollution. The experimental results of several dataset videos show the robustness and effectiveness of the proposed method.

1:50PM *Interpolation Techniques versus F-Transform in Application to Image Reconstruction [#F-14182]*

Pavel Vlasanek and Irina Perfilieva, University of Ostrava, Czech Republic; Centre of Excellence IT4Innovations, Czech Republic

Many interpolation techniques are available for image reconstruction, with differences in time complexity, memory complexity and quality. In this article, we compare the application of bilinear interpolation, nearest neighbor interpolation and the F-transform approximation technique to the problem of image reconstruction. Based on our results, F-transform achieves the best results in terms of quality.

2:10PM *Building a Framework for Recognition of Activities of Daily Living from Depth Images Using Fuzzy Logic [#F-14183]*

Tanvi Banerjee, James Keller and Marjorie Skubic, University of Missouri, United States

Complex activities such as instrumental activities of daily living (IADLs) can be identified by creating a hierarchical model of fuzzy rules. In this work, we present a framework to model a specific IADL - "making the bed". For this activity recognition, the need for a three level Fuzzy Inference System (FIS) model is shown. Simple features such as bounding box parameters were extracted from the foreground images and combined with 3D features extracted from the Kinect depth data. This was then fed as input to the three layered FIS for further analysis. Data collected from several participants were tested and evaluated. Such a framework can be used to model several other IADLS as well as basic activities of daily living (ADLs). Analysis of ADLs can be used to compare daily patterns in older adults to measure changes in behavior. This can then be used to predict health changes to assist older adults in leading independent lifestyles for longer time periods.

2:30PM *A Fuzzy Approach for Texture Contrast Modelling [#F-14202]*

Jesus Chamorro-Martinez, Pedro Martinez-Jimenez, Jose Manuel Soto-Hidalgo and Daniel Sanchez, University of Granada, Spain; University of Cordoba, Spain

In this paper, we propose to model the contrast of visual texture by means of a perceptual-based fuzzy approach. For this modelling, fuzzy sets defined on the domain of some of the most representative measures of the contrast property are employed. In order to obtain these fuzzy sets, a functional relationship between the computational values given by the measures and the human perception of contrast is learned. The goodness of each model is

analyzed and tested with the human assessments, allowing us to identify the most suitable one to represent the contrast of visual texture. Finally, several experiments are performed in order to show the application of the proposed fuzzy model for pattern recognition.

2:50PM *A Preliminary Study on Fingerprint Classification Using Fuzzy Rule-Based Classification Systems [#F-14214]*

Mikel Galar, Sanz Jose, Pagola Miguel, Humberto Bustince and Francisco Herrera, Universidad Publica de Navarra, Spain; University of Granada, Spain

In this work we analyze the competitiveness of fuzzy rule-based systems in comparison with black box models like support vector machines to deal with fingerprint classification problems. With this aim, we carry out an experimental study applying different feature extraction models (covering almost every kind of features that are usually considered in this problem) and three fingerprint databases of different qualities. The obtained results show the good behavior of fuzzy rule-based classification systems. Observing these results, new future lines are outlined, which could improve the classification performance achieved with the current models.

3:10PM *Fuzzy Logic Based Sclera Recognition [#F-14236]*

Abhijit Das, Umapada Pal, Miguel Ferrer Ballaster and Michel Blumenstein, GRIFFITH UNIVERSITY, India; Indian Statistical Institute, India; Universidad de Las Palmas de Gran Canaria, Spain; GRIFFITH UNIVERSITY, Australia

In this paper a sclera recognition and validation system is proposed. Here sclera segmentation was performed by Fuzzy logic-based clustering. Since the sclera vessels are not prominent, image enhancement was required. A Fuzzy logic-based Brightness Preserving Dynamic Fuzzy Histogram Equalization and discrete Meyer wavelet was used to enhance the vessel patterns. For feature extraction, the Dense Local Binary Pattern (D-LBP) was used. D-LBP patch descriptors of each training image are used to form a bag of features, which is used to produce the training model. Support Vector Machines (SVMs) are used for classification. The UBIRIS version 1 dataset is used here for experimentation. An encouraging Equal Error Rate (EER) of 4.31% was achieved in our experiments.

TuF1-4 Approximate Reasoning and Theory

Tuesday, July 8, 1:30PM-3:30PM, Room: 201D, Chair: Piero Bonissone and Jianqiang Yi

1:30PM *Reasoning with Words: A First Approximation [#F-14213]*

Clemente Rubio-Manzano and Pascual Julian-Iranzo, University of the Bio Bio, Chile; University of Castilla-La Mancha, Spain

This paper aims to propose a model of reasoning based on semantic relations among words and to incorporate it in the inference mechanism of a logic programming language. This model is integrated in a fuzzy logic programming framework and it is implemented into the Bousi-Prolog system by using WordNet. All this process is transparent to the programmer and the reasoning with words is automatic. The lexical semantics between symbols (words) provides us with the ability of reasoning with words and turns the knowledge representation in a more natural and less complex process.

1:50PM *Fuzzy Qualitative Simulation with Multivariate Constraints [#F-14261]*

Wei Pang and George Coghill, University of Aberdeen, United Kingdom

In this research we focus on dealing with fuzzy multivariate relations and how we could perform fuzzy qualitative simulation with models containing such relations. To achieve this, we extended Morven, a fuzzy qualitative reasoning framework, and propose novel types of constraints for the framework. We first introduced fuzzy multivariate function (FMF) constraints, and presented their corresponding constraints in higher differential planes of a Morven model. We then implemented the fuzzy multivariate monotonicity (FMM) relations by FMF constraints and MM_add constraints, another kind of constraints we proposed for Morven. In addition, we employed alpha-cut to determine the "strictness" of qualitative signs in the MM add constraints. Finally, proof-of- concept experiments were performed to validate the proposed constraints, and both fuzzy and non-fuzzy situations were considered in these experiments.

2:10PM *L-Fuzzy Inference [#F-14417]*

Jonathan Garibaldi and Christian Wagner, University of Nottingham, United Kingdom

In this paper, we present a complete inferencing framework based on L-fuzzy sets, comprising fuzzification, inferencing itself, and both linguistic and numeric defuzzification strategies. We present the algorithms for each step, and then present a range of worked examples to illustrate the methods. Finally, we compare the results with similar examples which carry out 'standard' Mandani- style inference. To the best of our knowledge, this is the first time that practical algorithms for complete L-fuzzy inference have been presented.

2:30PM *Uncertain Interval Algebra via Fuzzy/Probabilistic Modeling [#N-14503]*

Keyvan Sadgehi and Ben Goertzel, OpenCog Foundation, Iran; OpenCog Foundation, United States

A novel approach to uncertain temporal inference is presented. Allen's Interval Algebra is extended to fuzzy time- intervals via representing the latter as trapeziums with distinct beginning, middle and end. An uncertain version of the Interval Algebra composition table is developed via running a computer simulation in which a large number of fuzzy time-intervals are drawn from an assumed probability distribution.

2:50PM *New Links between Mathematical Morphology and Fuzzy Property-Oriented Concept Lattices [#F-14534]*

Juan Carlos Diaz, Nicolas Madrid, Jesus Medina and Manuel Ojeda-Aciego, University of Cadiz, Spain; Ostrava University, Czech Republic; University of Malaga, Spain

The theory of fuzzy property-oriented concept lattices is a formal tool for modeling and processing incomplete knowledge in information systems. This paper relates this research topic to that of mathematical morphology, a theory whose scope is to process and analyze images and signals. Consequently, the theory developed in the concept lattice framework can be used in these particular settings.

3:10PM *Discrete Fuzzy Transform of Higher Degree [#F-14481]*

Michal Holcapek and Tomas Tichy, University of Ostrava, Czech Republic; VSB TU-Ostrava, Czech Republic

In this paper, we reformulate the fuzzy transform of higher degree (F^m-transform) proposed originally for an approximation of continuous functions to the discrete case. We introduce two types of F^m-transform which components are defined using polynomials in the first case and using specific values of these polynomials in the second case. We provide an analysis of basic properties of F^m- transform.

Special Session: TuF1-5 Advances to Type-2 Fuzzy Logic Control

Tuesday, July 8, 1:30PM-3:30PM, Room: 303, Chair: Hao Ying and Tufan Kumbasar

1:30PM *A Method for Deriving the Analytical Structure of the TS Fuzzy Controllers with Two Linear Interval Type-2 Fuzzy Sets for Each Input Variable [#F-14034]*

Haibo Zhou and Hao Ying, Central South University, China; Wayne State University, United States

Type-2 fuzzy controllers have been mostly viewed and treated as black boxes in that their input-output mathematical mappings (i.e., analytical structures) are unknown. In contrast, this is never the case for any conventional controller. In this paper, we show an innovative analytical structure derivation technique for the interval Type-2 TS fuzzy controllers whose configurations are as follows: two input variables, two linear input fuzzy sets for each input variable, linear TS fuzzy rules, Zadeh AND operator, the Karnik-Mendel center- of-sets type reducer, and the centroid defuzzifier. Revealing the analytical structure of any Type-2 fuzzy controller, this one included, is important as it can lead to better understanding of the controller and more productive analysis and design of the Type-2 fuzzy control system.

1:50PM *Boundary Function Based Karnik- Mendel Type Reduction Method for Interval Type-2 Fuzzy PID Controllers [#F-14459]*

Mehmet Furkan Dodurka, Tufan Kumbasar, Ahmet Sakalli and Engin Yesil, Istanbul Technical University, Turkey

In this paper, we will present a Boundary Function (BF) based type reduction/ defuzzification method for Interval Type-2 Fuzzy PID (IT2-PID) controllers. Thus, we have presented a novel representation of the optimal Switching Points (SPs) of the Karnik Mendel (KM) method by first decomposing the IT2-FPID controller into SubControllers (SCs) and then derived Boundary Functions (BFs) to determine the optimal SPs of each SCs. Since the optimal SPs are calculated without an iterative algorithm, the explicit expressions of how the SPs are determined is represented in analytical structure via the proposed BFs. We have presented comparative studies where the computational time performance of the proposed BF-KM method is compared to the KM and the decomposition based KM methods. The presented results show that proposed method is superior in comparison to the other compared methods and feasible for especially real time control applications where there is a need of small sampling times. Keywords--Interval type-2 fuzzy PID controllers; Karnik- Mendel Method, Decomposition, Switicing Points.

2:10PM *The Simplest Interval Type-2 Fuzzy PID Controller: Structural Analysis [#F-14457]*

Ahmet Sakalli, Tufan Kumbasar, Mehmet Furkan Dodurka and Engin Yesil, Istanbul Technical University, Turkey

In this paper, we will present analytical derivations of the simplest the Interval Type-2 Fuzzy PID (IT2-FPID) controller output which is composed of only 4 rules. Thus, we will first propose a new visualizing method called Surface of the Switching Points (S-MAP) in order to better analyze the derivation of the Switching Points (SPs) of the Karnik-Mendel algorithms. We presented mathematical explanation of the S-MAP and showed that the SPs are determined by only two Boundary Functions (BFs) for the simplest IT2-FPID controller. We will then give the simplified analytical derivation of the simplest IT2-FPID controller around the steady state via the employed BFs and S-MAP. We have illustrated that the simplest IT2-FPID controller is in fact analogous to a conventional PID controller around the steady state. We presented the simplest IT2-FPID controller output in terms of the parameters of the antecedent IT2-FSs. We examined the effect of the design parameter over IT2-FPID control system performance. In the light of the observations, we presented a simple self-tuning mechanism to enhance the transient state and disturbance rejection performance. Keywords--Simplest Interval type-2 fuzzy PID controllers; Karnik- Mendel Method, Switicing Points.

2:30PM *Robust Stability Analysis of PD Type Single Input Interval Type-2 Fuzzy Control Systems [#F-14139]*

Tufan Kumbasar, Istanbul Technical University, United Kingdom

In this paper, the robust stability of a PD type Single input Interval Type-2 Fuzzy Logic Controller (SIT2-FLC) structure will be examined via the well-known Popov criterion and Lyapunov's direct method approach. Since a closed form formulation of the SIT2-FLC output is possible, the type-2 fuzzy functional mapping is analyzed in a two dimensional domain. Thus, mathematical derivations are presented to show that type-2 fuzzy functional mapping is a symmetrical function and always sector bounded. Consequently, the type-2 fuzzy system can be transformed into a perturbed Lur'e system to examine its robust stability. It has been proven that the stability of the PD type SIT2-FLC system is guaranteed with the aids of the Popov-Lyapunov method. A robustness measure of the type-2 fuzzy control system is also presented to give the bound of allowable uncertainties/ nonlinearities of the control system. Moreover, if this bound is known, the exact region of stability of the type-2 fuzzy system can be found since SIT2-FLC output can be presented in a closed form. An illustrate example is presented to demonstrate the robust stability analysis of the PD type SIT2- FLC system.

2:50PM *Hardware Implementation of a Novel Inference Engine for Interval Type-2 Fuzzy Control on FPGA [#F-14225]*

Matthew Schrieber and Mohammad Biglarbegian, University of Guelph, Canada

Interval type-2 fuzzy logic controllers (IT2 FLCs) have shown a promising potential in handling uncertainties compared to their type-1 counterparts, and as a result, we have witnessed increasing usage of IT2 FLCs in various applications. Due to the complex structures of IT2 FLCs, using them in real-time applications might be computationally expensive. To facilitate real-time implementation of these controllers, hardware with parallel processing abilities are recommended; field-programmable gate arrays (FPGA) are one class of such hardware. In this paper, we propose a structure for implementing a new IT2 FLC inference mechanism called BMM [2] - that has been recently introduced in the literature - on an FPGA. We first demonstrated how the proposed structure can be implemented on software; next, we proposed an implementation architecture for the IT2 FLC mechanism on hardware. We performed simulations and experiments on two different plants and compared the speed of our controllers. The performance speed as well as the tracking of our proposed control structure in simulations and experiments were shown to be very close to each other. Using the BMM engine for the proposed hardware structure proves to be faster than other existing controllers in the literature. Thus, it is expected that IT2 FLCs can be easily implemented on hardware to further enable their real-time applications.

3:10PM *Uncertain Nonlinear Time Delay Systems Fast and Large Disturbance Rejection Based on Adaptive Interval Type-2 Fuzzy PI Control [#F-14391]*

Tsung-Chih Lin and Chien-Liang Chen, Feng-Chia University, Taiwan

In this paper, adaptive interval type-2 fuzzy proportional integral (PI) control scheme to attenuate fast and large disturbance for a class of uncertain nonlinear time delay systems is proposed. By incorporating adaptive interval type-2 time delay fuzzy logic controller (AT2DFLC) with PI controller, not only the typical switching law chattering can be significantly attenuated but also the instability resulting from system time delay can be overcome. Based on the Lyapunov theory of stability, the free parameters of the AT2DFLC and PI controller coefficients can be tuned on-line by output feedback adaptive laws derived from Lyapunov function with time delays. Simulation results show that the chattering phenomena can be attenuated and the prescribed tracking performance can be preserved simultaneously by the advocated control scheme

Tuesday, July 8, 3:30PM-6:00PM

Poster Session: PF2 Fuzzy Modeling, Control, & Applications I

Tuesday, July 8, 3:30PM-6:00PM, Room: Posters Area (Level 2), Chair: Tsuyoshi Nakamura and Gwo-Ruey Yu

P301 *The Auto-Revising Method for Fuzzy Rule-Base [#F-14017]*

Feng Li, Zhengnan Wang, Mei Wang and Xiaoqiang Liu, Donghua University, China

To refine the fuzzy rule base, it is important to find out and remove the redundant rules in the large scale rule base automatically. On the topic, a synthetical process is described. The abstraction relationship between the clauses is presented firstly, and then the redundant rule is defined in strictly formal criteria on the base of three laws: Transitive Law, Precondition Specific Law and Conclusion Abstraction Law. Based on the theorems, the algorithm to revise the knowledge base is presented.

P302 *Hierarchical Fuzzy Sliding-Mode Control for Uncertain Nonlinear Under-Actuated Systems [#F-14070]*

Chiang-Cheng Chiang and Yao-Wei Yeh, Tatung University, Taiwan

This paper presents a hierarchical fuzzy sliding mode control scheme for a class of uncertain nonlinear under-actuated systems. First, the sliding surface of one subsystem is selected as the first layer sliding surface. Hence, we further construct a second layer sliding surface from the first layer sliding surface and the sliding surface of another subsystem till all the subsystem sliding surfaces are included. The fuzzy system and some adaptive laws are applied to approximate the unknown nonlinear functions and estimate the upper bounds of the unknown uncertainties, respectively. By means of Lyapunov stability theorem and the theory of sliding mode control, the proposed control scheme ensures the robust stability of the uncertain nonlinear under- actuated systems. Finally, simulation results show the validity of the proposed method.

P303 *Variance and Passivity Constrained Fuzzy Control for Continuous Perturbed Fuzzy Systems with Multiplicative Noises [#F-14073]*

Wen-Jer Chang and Bo-Jyun Huang, National Taiwan Ocean University, Taiwan

In this paper, a fuzzy controller design problem for continuous perturbed nonlinear stochastic systems with state multiplicative noises is investigated. In order to simultaneously achieve variance and passivity constrained performances, some sufficient conditions are derived based on the Lyapunov theory. These sufficient conditions are in term of the linear matrix inequality forms that can be solved by the convex optimal programming algorithm. Besides, the parallel distributed compensation concept is employed to construct the fuzzy controllers. Finally, a numerical simulation example is given to show the effectiveness and applicability of the proposed fuzzy control methodology.

P304 *Rapid Face Detection Using an Automatic Distributing Detector Based on Fuzzy Logic [#F-14096]*

Wanjuan Song, Wenyong Dong and Jian Zhang, Wuhan University, China

To improve the efficiency of a face detector, this paper presents an automatic distributing detector (ADD) based on the fuzzy theory to improve the performance of face detection. The main contributions lie in:1) A new Haar-like feature representation based on the fuzzy membership function is proposed, 2)The entropy of feature set is employed as choice criteria to select weak classifiers , 3) The AdaBoost algorithm is used to train weak classifiers, and 4)The distributor which can dynamically select stronger classifiers is constructed. The experiment results show that the proposed method not only determines rapidly the sub-window which contains the human face, but also tune the classifier dynamically to adaptive new samples.

P305 *Application of the Fuzzy Gain Scheduling IMC-PID for The Boiler Pressure Control [#F-14124]*

XiaoFeng Li, ShiHe Chen and Ruiyuan Wu, Electric Power Research Institute of Guangdong Power Group Co., China; South China University of Technology, China

In this paper, the use of a Fuzzy Gain Scheduling IMC-PID (FGS+IMC-PID) scheme has been presented based on fuzzy performance degree coefficient; self- adjusting controller for the improvement of IMC-PID control. It is shown that the IMC-PID controller with the Fuzzy PID parameters Gain Scheduler provides satisfactory closed-loop responses with less overshoot and shorter rising times in case of both set point disturbance and the plant model mismatch. Simulations are given, in which the proposed method is compared to other PID tuning methods (IMC, SPMG). The proposed scheme is suitable to implement in the complex process control system in power generation, since it does not demand significant computing resources. It has already been implemented through Function Code in many typical DCS (EDPU, XDPS, Ovation etc). The industrial applications show that the scheme achieves better performance in specific load variation range.

P306 *Fuzzy Contexts (Type-C) and Fuzzymorphism to Solve Situational Discontinuity Problems [#F-14170]*

Kevin McCarty and Milos Manic, University of Idaho, United States

Generalized solutions to complex problems often suffer from being overly complicated. The main contribution of this paper is to describe an architecture that allows for greater problem generalization without the traditional corresponding increase in complexity. The architecture extends traditional fuzzy logic and is called Fuzzy Contexts or Fuzzy Logic Type-C. Fuzzy logic permits partial membership and values can belong to multiple fuzzy sets. By breaking down a problem space into smaller contexts and allowing algorithms themselves to have relaxed memberships in those contexts, a Type-C solution can support multiple solutions to complex problems. This paper describes how problem spaces may be decomposed into smaller, more easily solvable components and fuzzified together under a Type-C hierarchy. Test results with a simulated robotic navigation system demonstrates how a Type-C implementation is able to improve upon a generalized fuzzy controller.

P307 *Improvement on Fuzzy-Model-Based Stability Criteria of Nonlinear Networked Control Systems [#F-14180]*

Haobin Chen, Bin Tang, Jianan Huang and Yun Zhang, Guangdong University of Technology, China

This paper is concerned with an improvement on fuzzy-model-based stability criteria of nonlinear networked control systems (NCSs) with time-varying transmission delays and transmission intervals. The real-time distribution of input delays is taken into account and modeled as a dependent and nonidentically distributed process, which leads to a randomly switched Takagi-Sugeno (T-S) fuzzy model with multiple input-delay subsystems for the nonlinear NCSs. Based on an improved Lyapunov-Krasovskii method, which appropriately takes into account the real-time distribution of input delays in estimating cross-product integral terms and the characteristics of T-S fuzzy model, new sufficient conditions are derived for the deterministic asymptotical stability of the overall systems. Numerical examples are presented to substantiate the effectiveness and advantage of our results.

P308 *Fuzzy Approximation Adaptive Control of Quadruped Robots with Kinematics and Dynamics Uncertainties [#F-14231]*

Zhijun Li, Shengtao Xiao and ShuZhi Sam Ge, South China University of Technology, China; National University of Singapore, Singapore

This paper investigates optimal feet forces distri- bution and control of quadruped robots with uncertainties in both kinematics and dynamics. First, a constrained dynamics of quadruped robots is established through adaptation to both the kinematic and dynamic uncertainties. Consider an external wrench on quadruped robots, the distribution of required forces and moments on the supporting legs of a quadruped robot can be formulated as a problem for minimizing an objective function subject to form-closure constraints and balance constraints of external force. The dynamics of recurrent neural network for real-time force optimization are proposed. For the obtained optimized tip-point force and the motion of legs, we propose the hybrid motion/force control based on adaptive fuzzy system to compensate for the external perturbation and the task-space tracking errors in the environment. The proposed control can confront the uncertainties including approximation task space error and external perturbation. The verification of the proposed control is conducted using the extensive simulations.

P309 *Fuzzy Proportional-Resonant Control Strategy for Three-Phase Inverters in Islanded Micro-Grid with Nonlinear Loads [#F-14232]*

Hongda Cai, Wei Wei, Yonggang Peng and Huiyong Hu, Zhejiang University, China; Zhejaing University, China

Conventional proportional-resonant controller is widely accepted and adopted in micro-grid applications. However, It's hard to design a satisfactory conventional proportion-resonant controller due to the contradictory nature of the inverter's stability, dynamic response speed and static tracking accuracy. Therefore, some trade-off strategies proposed in previous works are usually favored. This paper proposes a novel fuzzy proportional-resonant control strategy for a three-phase inverter, which can obtain better outcomes of three contradictory performance characteristics simultaneously. The detailed mathematical models and design procedure of the controller for the studied inverter are also presented. Compared with conventional proportional-resonant control strategy, the superiority of the proposed fuzzy proportional-resonant control strategy is significant for its better system stability, faster dynamic response speed and higher static tracking accuracy. Results from simulation are provided to verify the feasibility and effectiveness of the proposed approach.

P310 *Visual Servo Control of the Hexapod Robot with Obstacle Avoidance [#F-14269]*

Wen-Shyong Yu and Chiau-Wei Huang, Tatung University, Taiwan

This paper is to design a visual servo control for a hexapod robot with obstacle avoidance. The implementation of the motion control for the hexapod robot using the inverse kinematics and visual recognition system is used to achieve the trajectory tracking with obstacle avoidance. The control structure is composed of three parts: a tilt camera based on the concepts of mechanical geometry, visual servo control systems, and motion dynamics for trajectory tracking and obstacle avoidance. First, the depth between the obstacle and robot based on the proportion of the size of the area is constructed. Then, the image processing is used to identify whether there are any obstacles in the front, and make it as a feedback to the servo control system. For image recognition, we use OpenCV to process environment to the grayscale and binarization, filter noise through erosion and dilation, and then fill all of the contours using Sobel edge detection, and finally calculate the area and compare that with each other. Finally, some experiments for a hexapod robot with obstacle avoidance are used to validate the performance of the proposed control scheme.

P311 *Improved Observer-Based H-Infinity Control for Fuzzy Interconnected Systems [#F-14351]*

Xinrui Liu, Xinming Hou, Kunya Guo, Zongrang Li and Jinsong Zhang, Northeastern University, China; Shenyang Power Supply Company, China

In this paper, based on Lyapunov-Krasovskii functional approach and the decentralized control theory of interconnected systems, we consider the observer-based control design for a class of fuzzy descriptor interconnected systems. Firstly, the stability conditions of the T-S fuzzy model with a prescribed performance level are provided in theorem 1, but there is no efficient algorithm solving the inequalities. Theorem 2 proposes a single- step method, reducing the conservatism of the conditions. This method overcomes the drawback of the two-step approach in other methods. The stability conditions in theorem 1 are the sufficient and necessary conditions of the ones in theorem 2. The parameters of reliable controllers can be found via LMI toolbox in MATLAB software. Finally a numerical example is given to show the validity of the proposed method.

P312 *A Novel Adaptive Fuzzy Control for a Class of Discrete-Time Nonlinear Systems in Strict-Feedback Form [#F-14388]*

Xin Wang, Tieshan Li and Lin Bin, Dalian Maritime University, China

In this paper, a backstepping based adaptive fuzzy control algorithem is presented for a class of uncertain nonlinear discrete-time systems in the strict-feedback form. By introducing the "minimal learning parameter (MLP)" technique, the proposed scheme is able to circumvent the problem of "curse of dimension" for high-dimensional systems. Meanwhile, all the virtual control laws and actual control law in the system are updated by a novel actual adaptive update law, thus the number of parameters updated online for whole system is only by one. Takagi-Sugeno (T-S) fuzzy systems are used to approximate the unknown system functions. It is shown via Lyapunov theory that all signals in the closed-loop system are semi-globally uniformly ultimately bounded (SGUUB). Finally, a simulation example is employed to illustrate the effectiveness and advantages of the proposed scheme.

P313 *Design of MPPT by Using Interval Type-2 T-S Fuzzy Controller [#F-14395]*

Gwo-Ruey Yu, National Chung Cheng University, Taiwan

This paper proposes a maximum power point tracker (MPPT) which can accommodate widely output voltage range of solar panel under various environmental conditions. The controller in the MPPT employs the interval type-2 Takagi- Sugeno (IT2 TS) fuzzy technology. The main advantage of the proposed IT2 TS fuzzy controller is that it can handle the uncertainties in the

modeling process. The experimental results are implemented to demonstrate the capability of IT2 TS fuzzy controller compared to type-1 T-S fuzzy controller.

P314 *Robust Fuzzy Digital PID Controller Design Based on Gain and Phase Margins Specifications [#F-14453]*

Ginalber Serra and Danubia Pires, Federal Institute of Education, Science and Technology, Brazil

A robust fuzzy digital PID control methodology based on gain and phase margins specifications, is proposed. A mathematical formulation, based on gain and phase margins specifications, the Takagi-Sugeno fuzzy model of the plant to be controlled, the structure of the digital PID controller and the time delay uncertain system, was developed. A multiobjective genetic strategy is defined to tune the fuzzy digital PID controller parameters, so the gain and phase margins specified to the fuzzy control system are get. An analysis of necessary and sufficient conditions for fuzzy digital PID controller design with robust stability, with the proposal of the two theorems, is presented. Experimental results show the efficiency of the proposed methodology, applying on a platform control in real time of a thermal plant through tracking of the reference and the gain and phase margins keeping closed of the specified ones.

P315 *Fuzzy Control for Kite-Based Tethered Flying Robot [#F-14469]*

Tohru Ishii, Yasutake Takahashi, Yoichiro Maeda and Takayuki Nakamura, University of Fukui, Japan; Osaka Institute of Technology, Japan; Wakayama University, Japan

Information from the sky is important for rescue activity in large-scale disaster or dangerous areas. Observation system using a balloon or an airplane has been studied as an information gathering system from the sky. A balloon observation system needs helium gas and relatively long time to be ready. An airplane observation system can be prepared in a short time and its mobility is good. However, a long time flight is difficult because of limited amount of fuel. We have proposed and developed a kite-based observation system that complements activities of balloon and airplane observation systems by short preparation time and long time flight. This research aims at construction of the autonomous flight information gathering system using a tethered flying unit that consists of the kite and the ground tether line control unit with a winding machine. This paper proposes fuzzy controllers for the kite type tethered flying robot inspired by how to fly a kite by a human.

Tuesday, July 8, 4:00PM-6:00PM

Special Session: TuF2-1 Computing with Words and Fuzzy Natural Language Processing

Tuesday, July 8, 4:00PM-6:00PM, Room: 201A, Chair: Jerry Mendel

4:00PM *On the Creation of a Fuzzy Dataset for the Evaluation of Fuzzy Semantic Similarity Measures [#F-14076]*

Keeley Crockett, David Chandran and David Mclean, Manchester Metropolitan University, United Kingdom

Short text semantic similarity (STSS) measures are algorithms designed to compare short texts and return a level of similarity between them. However, until recently such measures have ignored perception or fuzzy based words in calculations of both word and sentence similarity. Evaluation of such measures is usually achieved through the use of benchmark data sets comprising of a set of rigorously collected sentence pairs which have been evaluated by human participants. A weakness of these datasets is that the sentences pairs include limited, if any, fuzzy based words that makes them impractical for evaluating fuzzy sentence similarity measures. In this paper, a method is presented for the creation of a new benchmark dataset known as SFWD (Single Fuzzy Word Dataset). After creation the data set is then used in the evaluation of FAST, an ontology based fuzzy algorithm for semantic similarity testing that uses concepts of fuzzy and computing with words to allow for the accurate representation of fuzzy based words. The SFWD is then used to undertake a comparative analysis of other established STSS measures.

4:20PM *A Numerical Two-Scale Model of Multi-Granularity Linguistic Variables and Its Application to Group Decision Making [#F-14082]*

Mei Cai, Xiuzhi Sang and Xinwang Liu, Nanjing University of Information Science and Technology, China; Southeast University, China

Many group decision making (GDM) problems under uncertain environments have vague and imprecise information in linguistic variable formats. Multi-granularity linguistic method with the process of symbolic computation is a typical tool to solve such problems, and can be associated with the popular computing with words domain. In the paper, we present numerical two-scale model which is the extension of symbolic computation model. Firstly, numerical two- scale representation model is proposed with two scale measurements. One is used to reflect the order of linguistic variable and the other is used to model vagueness. Secondly, we give numerical two-scale computational model in group decision making. We discuss the rules of symbolic method which directly compute with the two numerical measurements. Finally, some aggregation operators are developed. The new model has the advantage of avoiding the vague information losing without adding the calculation difficulty.

4:40PM *Determining Interval Type-2 Fuzzy Set Models for Words Using Data Collected from One Subject: Person FOUs [#F-14141]*

Jerry Mendel and Dongrui Wu, University of Southern California, United States; GE Global Research, United States

This paper provides a new methodology for determining a word's interval type-2 fuzzy set model using only one subject, a Person FOU. It uses interval end-point uncertainty intervals instead of only the end- point intervals. Such uncertainty intervals are relatively easy to collect and they do not introduce methodological uncertainties during the data-collection process. This new method is applied to ten probability words. Person FOUs are obtained for these words, and the robustness of this new method to the choice of the probability distribution that is assigned to the interval end- point uncertainty intervals is examined and demonstrated.

5:00PM *Twitter Topic Fuzzy Fingerprints [#F-14383]*

Hugo Rosa, Fernando Batista and Joao Paulo Carvalho, Universidade de Lisboa, Portugal

In this paper we propose to approach the subject of Twitter Topic Detection using a new technique called Topic Fuzzy Fingerprints. A comparison is made with two popular text classification techniques, Support Vector Machines (SVM) and k-Nearest Neighbours (kNN). Preliminary results show that Twitter Topic Fuzzy Fingerprints outperforms the other two techniques achieving better Precision and Recall, while still being much faster, which is an essential feature when processing large volumes of streaming data.

5:20PM *On the Use of Hesitant Fuzzy Linguistic Term Set in FLINTSTONES [#F-14409]*

Francisco J. Estrella, Rosa M. Rodriguez, Macarena Espinilla and Luis Martinez, University of Jaen, Spain

The use of linguistic information to model and manage uncertainty in Decision Making (DM) has been a key subject of many proposals in the literature. The 2- tuple linguistic model and its extensions in linguistic DM has been very successful and extensive due to their flexibility and accuracy. Flintstones is a novel fuzzy linguistic decision tool enhancement suite that implements tools to facilitate the solving of linguistic DM problems that model the linguistic information with such a model and its extensions. However, both the 2-tuple linguistic model and Flintstones can not deal with uncertain situations modelled linguistically in which experts hesitate among several linguistic terms. For these cases, recently, it has been proposed the use of Hesitant Fuzzy Linguistic Term Sets (HFLTS) that have attracted a lot of research interest, mainly regarding its application in DM. Hence in this contribution it is proposed an extended version of Flintstones that includes the ability and functionality of dealing with HFLTS in linguistic decision problems and enables the integration, validity and performance of hesitant linguistic decision models and operators.

5:40PM *Exploring Statistical Attributes Obtained from Fuzzy Agreement Models [#F-14442]*

Simon Miller, Christian Wagner and Jonathan Garibaldi, University of Nottingham, United Kingdom

In this paper we explore the characteristics of Type- 1 Fuzzy Set agreement models based on interval data through contrasting statistical measures of the fuzzy models and the raw data respectively. We create Type-1 Fuzzy Set models using the Interval Agreement Approach, and then extract a preliminary set of attributes that encapsulate aspects of the agreement models. In order to explore what these attributes can tell us, we compare them with a set of traditional statistical measures of consensus which are applied to the raw data. Two interval-valued survey data sets are employed in this study, a synthetic data set consisting of 30 groups of 10 experts rating 25 objects which is used to provide a large example, and a real-world data set consisting of 7 groups of 4-8 cyber-security experts rating 26 security components that was collected during a decision making exercise at GCHQ, Cheltenham, UK. We show that while there are areas in which traditional methods and the attributes extracted from the Type-1 Fuzzy Set agreement models overlap, there are also attributes that do not appear to be replicated, suggesting that these attributes contain additional information about the consensus within the groups. A discussion of the results is provided, along with the conclusions that can be drawn and considerations for future work on this subject.

Special Session: TuF2-2 Applications of Type-2 Fuzzy Systems

Tuesday, July 8, 4:00PM-6:00PM, Room: 201B, Chair: Christian Wagner

4:00PM *A General Type-II Similarity Based Model for Breast Cancer Grading with FTIR Spectral Data [#F-14458]*

Shabbar Naqvi, Simon Miller and Jonathan Garibaldi, University of Nottingham, United Kingdom

Breast cancer is one of the most frequently occurring cancers among women throughout the world. In breast cancer prognosis, grading plays an important role. In this paper, we apply a novel method based on type-II fuzzy logic to Fourier Transform Infra-red Spectroscopy based breast cancer spectral data for the classification of breast cancer grade. A FTIR spectral data set consisting of 14 cases of breast cancer has been used. A zSlices based type-II fuzzy logic approach has been used to create prototype models for the classification of unseen breast cancer cases. The prototype models are used with a similarity measure to classify unseen cases of cancer. We have shown that the T-II similarity based model is a promising methodology for classification.

4:20PM *An Interval Type-2 Fuzzy Logic Based System with User Engagement Feedback for Customized Knowledge Delivery within Intelligent E-Learning Platforms [#F-14204]*

Khalid Almohammadi, Bo Yao and Hani Hagras, University of Essex, United Kingdom

The recent years have witnessed an expansion on realizing adaptive educational systems for intelligent E-learning platforms. Such platforms permit the development of customised learning contexts adapted to the requirements of every student by correlating the student characteristics with instructional variables. However, the vast majority of the existing adaptive educational systems do not learn from the users' behaviors to create white box models which could handle the linguistic uncertainties and could be easily read and analyzed by the lay user. Moreover, most of the existing systems ignore gauging the students engagements levels and mapping them to suitable delivery needs which match the students knowledge and preferred learning styles. This paper presents a novel interval type-2 fuzzy logic based system that can learn the users' preferred knowledge delivery needs and the preferred learning style based on the students characteristics and engagement levels to generate a customized learning environment. The paper presents a novel system for gauging the students' engagement levels based on utilizing visual information to automatically calculate the engagement degree of students. This differs from traditional methods which usually employ expensive and invasive sensors. Our approach only uses a low-cost RGB-D video camera (Kinect, Microsoft) operating in a non-intrusive mode where the users are allowed to act and move without restrictions. The efficiency of the proposed system has been tested through various real-world experiments with the participation of 15 students.

4:40PM *Fuzzy Perceptron with Pocket Algorithm in Postoperative Patient Data Set [#F-14549]*

Suwannee Phitakwinai, Sansanee Auephanwiriyakul and Nipon Theera-Umpon, Chiang Mai University, Thailand

Classification is one of the problems in pattern recognition. Most of the time this problem will deal with data sets that are in numeric form and represented by vectors of numbers. Since there might be uncertainties embedded in a data set, it is more natural to represent the data set as fuzzy vectors. Hence, in this paper, we develop a fuzzy perceptron with pocket algorithm for fuzzy vectors. This algorithm is based on the extension principle and the decomposition theorem. We implement this algorithm on both synthetic and a real-world data set, i.e., the postoperative patient data. We also compare the result from the fuzzy perceptron with pocket algorithm with that from the regular perceptron with pocket algorithm. The comparison is done on the fuzzy perceptron with and without pocket as well.

5:00PM *A Type-2 Fuzzy Logic System for Linguistic Summarization of Video Sequence in Indoor Intelligent Environments [#F-14257]*

Bo Yao, Hani Hagras, Daniyal Alghazzawi and Mohammed J. Alhaddad, University of Essex, Great Britain; King Abdulaziz University, Saudi Arabia

Video monitoring can provide vital context awareness information from indoor intelligent environments where privacy is not a limitation. However, there is a need to develop linguistic summarization tools which are capable of summarizing in a layman language the information of interest within long video sequences. The key module which can enable the linguistic summarization of video monitoring is human activity/behaviour recognition. However, human behavior recognition is an important yet challenging task due to the behavior uncertainty, activity ambiguity, and uncertain factors such as position, orientation and speed, etc. In order to handle such high levels of uncertainties in activity analysis, we introduce a system based on Interval Type-2 Fuzzy Logic Systems (IT2FLSs) whose parameters are optimized by the Big Bang-Big Crunch (BB-BC) algorithm which allows for robust behaviour recognition using 3D machine vision techniques in intelligent environments. We present several experiments which were performed in real-world intelligent environments to fairly make comparisons with the state-of-the-art algorithms. The experimental results demonstrate that the proposed BB-BC paradigm is effective in tuning the parameters of the membership functions and the rule base of the IT2FLSs to improve the recognition accuracy. It will be shown through real-world experiments that the proposed IT2FLSs outperformed the Type-1 FLSs (T1FLSs) counterpart as well as other traditional non-fuzzy based systems. Based on the recognition results, higher-level applications will presented including video linguistic summarizations event searching and activity retrieval/playback.

5:20PM *Designing Practical Interval Type-2 Fuzzy Logic Systems Made Simple [#F-14025]*

Dongrui Wu and Jerry Mendel, GE Global Research, United States; University of Southern California, United States

Interval type-2 fuzzy logic systems (IT2 FLSs) have become increasingly popular in the last decade, and have demonstrated superior performance in a number of applications. However, the computations in an IT2 FLS are more complex than those in a type-1 FLS, and there are many choices to be made in designing an IT2 FLS, including the shape of membership functions (Gaussian or trapezoidal), number of membership functions, type of fuzzifier (singleton or non-singleton), kind of rules (Mamdani or TSK), type of t-norm (minimum or product), method to compute the output (type-reduction or not), and methods for tuning the parameters (gradient-based methods or evolutionary computation algorithms; one-step or two-step). While these choices give an experienced IT2 FLS researcher extensive freedom to design the optimal IT2 FLS, they may look overwhelming and confusing to IT2 beginners. Such a beginner may make an inappropriate choice, obtain unexpected results, and lose interest, which will hinder the wider applications of IT2 FLSs. In this paper we try to help IT2 beginners navigate through the maze by recommending some representative choices for an IT2 FLS design. We also clarify two myths about IT2 FLSs. This paper will make IT2 FLSs more accessible to IT2 beginners.

5:40PM *Real-Time Power Aware Scheduling for Tasks with Type-2 Fuzzy Timing Constraints [#F-14511]*

Rahul Nath, Amit K. Shukla and Pranab Muhuri, South Asian University, India

The timing constraint of tasks in the mobile real-time computing systems plays the central role in deciding the task schedule as timely completion of the task is very important in such systems. These timing constraints are however completely unquantifiable during the time of system modeling and designing. Thus we consider type-2 fuzzy sets for modeling the timing constraints in mobile and time-critical computing systems and propose a new algorithm FT2EDF (Fuzzy Type-2 Earliest Deadline First) for task scheduling. On the other hand, because of the limitation of the storage power, power efficiency is another foremost design objective for designing mobile real-time computing systems. However, reduction of processor power pulls down the system performance. Timely task completion and power efficiency are therefore two mutually conflicting criteria. In this paper, we propose a heuristic based solution approach that with a modified version of the non-dominated sorting genetic algorithm-II (NSGA-II). Our approach allows that a processor dynamically switches between different voltage levels to ensure optimum reduction in the power requirements without compromising the timeliness of the task completion. The efficacy of our approach is demonstrated with two numerical examples. Comparison with the previous results show that our solution ensures approximately 44% of energy saving as compared to the around 25% of the earlier results.

Special Session: TuF2-3 Computational Intelligence for Human-centred Applications

Tuesday, July 8, 4:00PM-6:00PM, Room: 201C, Chair: Giovanni Acampora

4:00PM *An Optimization Model for FML-Based Decision Support System on Energy Management [#F-14329]*

Mei-Hui Wang, Pi-Jen Hsieh, Chang-Shing Lee, David Lupien St-Pierre and Che-Hung Liu, National University of Tainan, Taiwan; TAO, INRIA, France

Global warming causes increasing natural disasters and gradually threatens human life and property safety. Under such an uncertain environment, efficiency and effectiveness in the energy management are an important and a difficult question. This paper aims to provide an approach for energy management that optimizes the relationship between different variables such as time, areas, countries, users, seasons, evaluation methods, and various different energy productions such as nuclear, water, biomass, wind, solar, and thermal. To achieve this goal, this paper combines the technologies of ontology and fuzzy markup language (FML) with theories about uncertainty to evaluate the applicability of the energy production based on technological innovation, economic development, social safety, environmental protection, regional characteristics, and time series. The simulation results show that the proposed approach is feasible to provide an alternative for energy management through the viewpoints of people, governments, and enterprises.

4:20PM *Extending FML with Evolving Capabilities through a Scripting Language Approach [#F-14430]*

Giovanni Acampora, Marek Reformat and Autilia Vitiello, Nottingham Trent University, United Kingdom; University of Alberta, Canada; University of Salerno, Italy

The introduction of Fuzzy Markup Language (FML) in 2004 has initiated an important trend in Computational Intelligence research: the application of new web technologies to create more flexible and hardware independent environment for deploying "fuzzy ideas". FML allows researchers and engineers to focus on problem solving activities bypassing additional difficulties related to programming or physical equipment constraints. From that moment on, many researches have been using FML and other XML-based languages for modeling and developing fuzzy systems. However, in spite of their hardware interoperability, XML languages are able to model a fuzzy system in static way and, consequently, they do not provide any support for modelling "evolving" and temporal-based fuzzy systems, as such Timed Automata based Fuzzy Controllers. To address this deficiency, this paper introduces an extension of FML called FMLScript. It is based on a scripting language concept and allows for modelling XMLbased systems that can dynamically modify their configurations. As the consequence, a better expressive power can be achieved when compared with static modelling approaches. This is shown in a case study involving a smart grid control.

4:40PM *A Fuzzy Logic Based Reputation System for E-Markets [#F-14431]*

Giovanni Acampora, Arcangelo Castiglione and Autilia Vitiello, Nottingham Trent University, United Kingdom; University of Salerno, Italy

During the last years, electronic markets (e-markets) are emerging as a new idea of economy, where trade transactions can be performed by buyers and sellers even if they are separated by geographic boundaries, time differences or distance barriers. Unfortunately, in this on- line trade environment, the probability of large-scale fraud and deceit is higher than traditional commerce because of the lack of face- to-face communications. For this reason, reputation systems, which enable to assess the trustiness level of transacting parties, are becoming a fundamental component of any current e- market portal. In this paper, we propose a new fuzzy logic based reputation system capable of efficiently assessing transacting parties through the exploitation of 1) a fuzzy trust model which takes into account a set of metrics reflecting the trust human perception both on seller and buyer side and, furthermore, it does not miss to consider past transactions; 2) a fuzzy based reputation aggregation taking into account credibility concept to discriminate false trust values. As shown by performed experiments, the proposed reputation system yields better performance than that used by one of the most known e-markets, eBay.

5:00PM *Activities Recognition and Worker Profiling in the Intelligent Office Environment Using a Fuzzy Finite State Machine [#F-14452]*

Caroline Langensiepen, Ahmad Lotfi and Puteh Saifullizam, Nottingham Trent University, United Kingdom; Universiti Tun Hussein Onn Malaysia, Malaysia

Analysis of the office workers' activities of daily working in an intelligent office environment can be used to optimize energy consumption and also office workers' comfort. To achieve this end, it is essential to recognise office workers' activities including short breaks, meetings and non-computer activities to allow an optimum control strategy to be implemented. In this paper, fuzzy finite state machines are used to model an office worker's behaviour. The model will incorporate sensory data collected from the environment as the input and some pre-defined fuzzy states are used to develop the model. Experimental results are presented to illustrate the effectiveness of this approach. The activity models of different individual workers as inferred from the sensory devices can be distinguished. However, further investigation is required to create a more complete model.

5:20PM *An Extended Neuro-Fuzzy Approach for Efficiently Predicting Review Ratings in E-Markets [#F-14456]*

Giovanni Acampora, Georgina Cosma and Taha Osman, Nottingham Trent University, United Kingdom

Internet has opened new interesting scenarios in the fields of commerce and marketing. In particular, the idea of e-commerce has enabled customers to perform their trans- actions in a faster and cheaper way than conventional markets, and it has allowed companies to increase their sales volume thanks to a world- wide visibility. However, one of the problems that can strongly affect the performance of any e-commerce portal is related to the quality and validity of ratings provided by customers in their past transactions. Indeed, these reviews are used to determine the extent of customers acceptance and satisfaction of a product or service and they can affect the future selling performance and market share of a company. As a consequence, an efficient analysis of customers feedbacks could allow e-commerce portals to improve their selling capabilities and incomings. This paper introduces an innovative compu- tational intelligence framework for efficiently learning review ratings in e-commerce by addressing different issues involved in this significant task: the dimension and imprecision of ratings data. In particular, we integrate techniques as Singular Value Decomposition (SVD), Fuzzy C-Means (FCM) and ANFIS and, as shown in experimental results, this synergetic approach yields better learning performance than other rating predictors based on a conventional artificial neural network and FCM algorithm.

5:40PM *Type-2 Fuzzy Set Construction and Application for Adaptive Student Assessment System [#F-14553]*

Mei-Hui Wang, Chi-Shiang Wang, Chang-Shing Lee, Su-Wei Lin and Pi-Hsia Hung, National University of Tainan, Taiwan

Student's performance is classified into four levels, including below basic, basic, proficient, and advanced levels. The descriptions of the performance standard make students understand their learning achievement via percentile rank (PR), a norm-referenced score, and T score (T). This paper develops an adaptive student assessment system and invites elementary-school students to do a test in mathematics. Additionally, one adaptive item selection strategy mechanism is developed to choose next item that meets the student's current estimated ability. After that, the response data are collected to execute the type-2 fuzzy set (T2FS) construction mechanism to build a personalized T2FS for each student's performance and a T2FS for all students with an identical level. Finally, the student evaluation mechanism is executed to show students and teachers some useful information to assist in their future teaching and guidance. The simulation results show the proposed approach is feasible to adaptively select items from the item bank and construct T2FS for students' ability. In the future, we plan to use the technologies of optimization and computational intelligence to infer each student's ability in the test based on the constructed T2FSs.

TuF2-4 Fuzzy Control and Intelligent Systems II

Tuesday, July 8, 4:00PM-6:00PM, Room: 201D, Chair: Chin-Teng Lin and Timothy Havens

4:00PM *Fuzzy Sliding Surface Control of Wind-Induced Vibration [#F-14149]*

Suresh Thenozhi and Yu Wen, CINVESTAV-IPN, Mexico

Although normal fuzzy sliding mode controllers can reduce the chattering problem in building structure control, there are some problems such as they need the equivalent control and the upper bounds of the uncertainties. In this paper, we use fuzzy logic to approximate the sliding surface for the sliding mode control. The stability of the proposed controller is established. A six-story building prototype equipped with an active mass damper is used to demonstrate the effectiveness of the proposed controller towards the wind-induced vibration.

4:20PM *Automatic Tuning of PID Controllers in Engine Control Units by Means of Local Model Networks and Evolutionary Optimization [#F-14224]*

Christian Mayr, Nikolaus Euler-Rolle and Stefan Jakubek, AVL List GmbH, Austria; Vienna University of Technology, Austria

In this work a new approach for a fully automated calibration of nonlinear PID controllers and feedforward maps is introduced. Controller design poses a particularly challenging task in the application to internal combustion engines due to the nonlinear controller structure, which is usually prescribed by the manufacturer of the engine control unit (ECU). A dynamic local model network is used to represent the actual physical process as its architecture

can beneficially be adopted for scheduling of the nonlinear controller parameters. The presented calibration technique uses a genetic algorithm to calibrate the nonlinear PID controller and a static model inversion to determine the feedforward map. Finally, an example demonstrates the effectiveness of the proposed method.

4:40PM *Stabilization Analysis of Single-Input Polynomial Fuzzy Systems Using Control Lyapunov Functions [#F-14323]*

Radian Furqon, Ying-Jen Chen, Motoyasu Tanaka, Kazuo Tanaka and Hua O. Wang, The University of Electro-Communications, Japan; Boston University, United States

This paper presents a novel method for stabilization analysis of the single-input polynomial fuzzy systems using a sum of squares (SOS) approach to construct control Lyapunov functions (CLFs) for the systems. First, we represent a nonlinear system as a polynomial fuzzy system. Then, sufficient conditions in SOS terms for a positive definite function to become a CLF is presented. We solve the sufficient conditions using SOS optimization technique to construct the CLF. Finally, after a CLF is constructed, the controller for the system is designed using Sontag's formula. To illustrate the validity of the proposed approach, a design example is provided.

5:00PM *Real Time Fuzzy Controller for Quadrotor Stability Control [#F-14389]*

Pranav Bhatkhande and Timothy Havens, Michigan Technological University, United States

In this paper, we develop an intelligent neuro-fuzzy controller by using adaptive neuro fuzzy inference system (ANFIS) techniques. We begin by starting with a standard proportional- derivative (PD) controller and use the PD controller data to train the ANFIS system to develop a fuzzy controller. We then propose and validate a method to implement this control strategy on commercial off-the-shelf (COTS) hardware. Using model based design techniques, the models are implemented on an embedded system. This enables the deployment of fuzzy controllers on enthusiast-grade controllers. We evaluate the feasibility of the proposed control strategy in a model-in-the-loop simulation. We then propose a rapid prototyping strategy, allowing us to deploy these control algorithms on a system consisting of a combination of an ARM-based microcontroller and two Arduino-based controllers.

5:20PM *Robust Adaptive Fuzzy Control of Uncertain Bilinear Systems with Unknown Dead-Zone [#F-14059]*

Chiang-Cheng Chiang and Chao-Yu Cheng, Tatung University, Taiwan

A robust adaptive fuzzy control approach is proposed in this paper for a class of uncertain bilinear systems with unknown dead-zone. Dead-zone is one of the most important nonsmooth nonlinearities encountered in actuators, such as DC servo systems, pressure control systems, machine tools, and power amplifiers. In most practical motion systems, the dead-zone parameters are poorly known and may severely limit system performance. Therefore, the design of the robust adaptive fuzzy controller in this paper provides robustness not only to uncertainties of the system, but also to the unknown dead-zone. Based on Lyapunov stability theorem, the proposed robust adaptive fuzzy controller would have the capability to ensure the successful achievement of the asymptotic stabilization of the whole close-loop system. Simulation results are included to illustrate the effectiveness of the proposed control scheme.

5:40PM *Structure and Parameter Optimization of FNNs Using Multi-objective ACO for Control and Prediction [#F-14041]*

Chia-Feng Juang and Chia-Hung Hsu, National Chung-Hsing University, Taiwan

Design of a fuzzy neural network (FNN) consists of optimization of network structure and parameters. The objectives are to minimize the network model size with minimum training error at the same time, causing a conflict between the two objectives in the design problem. To address this problem, the multi-objective, rule-coded, advanced, continuous-ant-colony optimization (MO-RACACO) is applied to design FNNs in this paper. The MO-RACACO-designed FNNs are applied to time sequence prediction and nonlinear control problems to verify its performance. Performance of this approach is verified through three simulation examples with comparisons with various multi-objective population- based optimization algorithms and detailed discussions of the results. The results show that the MO-RACACO-based FNN design approach outperforms the multi- objective population-based algorithms used for comparisons in the control and prediction examples.

Industrial Session: TuF2-5 CI on Big Data and Social Networks

Tuesday, July 8, 4:00PM-6:00PM, Room: 303, Chair: Catherine Huang

4:00PM *Exploiting Homophily-Based Implicit Social Network to Improve Recommendation Performance [#N-14580]*

Tong Zhao, Junjie Hu, Pinjia He, Huang Fan, Irwin King and Michael Lyu, The Chinese University of Hong Kong, Hong Kong

Social information between users has been widely used to improve the traditional Recommender System in many previous works. However, in many websites such as Amazon and eBay, there is no explicit social graph that can be used to improve the recommendation performance. Hence in this work, in order to make it possible to employ social recommendation methods in those non-social information websites, we propose a general framework to construct a homophily-based implicit social network by utilizing both the rating and comments of items given by the users. Our scalable framework can be easily extended to enhance the performance of any recommender systems without social network by replacing the homophily-based implicit social relation definition. We propose four methods to extract and analyze the implicit social links between users, and then conduct the experiments on Amazon dataset. Experimental results show that our proposed methods work better than traditional recommendation methods without social information

4:20PM *Anomaly Detection Based on Indicators Aggregation [#N-14738]*

Tsirizo Rabenoro, Jerome Lacaille, Marie Cottrell and Fabrice Rossi, University Paris 1, France

Automatic anomaly detection is a major issue in various areas. Beyond mere detection, the identification of the source of the problem that produced the anomaly is also essential. This is particularly the case in aircraft engine health monitoring where detecting early signs of failure (anomalies) and helping the engine owner to implement efficiently the adapted maintenance operations (fixing the source of the anomaly) are of crucial importance to reduce the costs attached to unscheduled maintenance. This paper introduces a general methodology that aims at classifying monitoring signals into normal ones and several classes of abnormal ones. The main idea is to leverage expert knowledge by generating a very large number of binary indicators. Each indicator corresponds to a fully parametrized anomaly detector built from parametric anomaly scores designed by experts. A feature selection method is used to keep only the most discriminant indicators which are used at inputs of a Naive Bayes classifier. This give an interpretable classifier based on interpretable anomaly detectors whose parameters have been optimized indirectly by the selection process. The proposed methodology is evaluated on simulated data designed to reproduce some of the anomaly types observed in real world engines.

4:40PM *Mixture Modeling and Inference for Recognition of Multiple Recurring Unknown Patterns [#N-14769]*

Zeyu You, Raviv Raich and Yonghong Huang, Oregon State University, United States; Intel, United States

We consider the problem of finding unknown patterns that are recurring across multiple sets. For example, finding multiple objects that are present in multiple images or a short DNA code that is repeated across multiple DNA sequences. Earlier work on the topic includes a statistical modeling approach in which the same template is placed at a random position in multiple independent sets. Using mixture modeling, we propose an extension to the approach that allows the detection of multiple templates placed across multiple sets. Moreover, we present an expectation-maximization algorithm for jointly estimating multiple templates based on a mixture of non-Gaussian distributions. To address the non-convexity of the problem, a robust initialization method is presented and theoretical guarantees are provided. We evaluate the performance of the algorithm on both synthetic data and real- world data consisting of electrical voltage recordings of home appliance activations. Our results indicate that the proposed algorithm significantly improves the detection accuracy of home appliances.

5:00PM *Investigating the Quality of a Bibliographic Knowledge Base Using Partitioning Semantics [#F-14035]*

Lea Guizol and Madalina Croitoru, LIRMM, France

With the aim of evaluating and improving link quality in bibliographical knowledge bases, we develop a decision support system based on partitioning semantics. Two such semantics have been proposed, the novelty of this approach consisting on using symbolic values criteria for partitioning. In this paper we investigate the limits of those partitioning semantics: how the characteristics of the input (objects and criteria) influences characteristics of result, namely correctness of result and execution time.

5:20PM *A Structure Optimization Algorithm of Neural Networks for Large-Scale Data Sets [#F-14203]*

Jie Yang, Jun Ma, Matthew Berryman and Pascal Perez, University of Wollongong, Australia

Over the past several decades, neural networks have evolved into powerful computation systems, which are able to learn complex nonlinear input-output relationship from data. However, the structure optimization problem of neural network is a big challenge for processing huge-volumed, diversified and uncertain data. This paper focuses on this problem and introduces a network pruning algorithm based on sparse representation, termed SRP. The proposed approach starts with a large network, then selects important hidden neurons from the original structure using a forward selection criterion that minimizes the residual output error. Furthermore, the presented algorithm has no constraints on the network type. The efficiency of the proposed approach is evaluated based on several benchmark data sets. We also evaluate the performance of the proposed algorithm on a real-world application of individual travel mode choice. The experimental results have shown that SRP performs favorably compared to alternative approaches.

5:40PM *Model Based Lithium Ion Cell Ageing Data Analysis [#F-14177]*

Christoph Hametner, Wenzel Prochazka, Amra Suljanovic and Stefan Jakubek, Vienna University of Technology, Austria; AVL List GmbH, Austria

This paper reports the model based analysis of Lithium Ion cell ageing and the age-related adaptation of data driven battery models is addressed. To take account of ageing is an important issue e.g. for the battery management of (hybrid) electrical vehicles, in order to provide an exact online estimate of the state of charge (SoC). As a first step, ageing data analysis based on the architecture of local model networks (LMNs) is presented using data from a large scale ageing experiment of Lithium Ion cells. Additionally, the topic of time-variant battery modelling is addressed. Thus, the LMN is adapted in a way that age-related effects (such as capacity decay and resistance increase) are taken into account. Such a model can further be used for the design of a combined observer for SoC and state of health (SoH).

Wednesday, July 9, 1:30PM-3:30PM

Special Session: WeF1-1 Human Symbiotic Systems I

Wednesday, July 9, 1:30PM-3:30PM, Room: 201A, Chair: Yoichiro Maeda

1:30PM *A Study on Improvement of Serendipity in Item-Based Collaborative Filtering Using Association Rule [#F-14196]*

Hiroaki Ito, Tomohiro Yoshikawa and Takeshi Furuhashi, Nagoya University, Japan

The number of available items in online shops are increasing by the spread of the Internet recently. Though users have a wide range of choices, they need to find their favorite items from a huge amount of information. Thus, a variety of recommendation systems are currently in use. "Accuracy," which is the ratio of the number of user's favorite items over that of recommended items, is the most important index in these recommendation systems. However, not only "Accuracy" but also "Serendipity" is said to be needed in terms of user satisfaction recent years. Recommendation system is categorized into 2 types. One is based on collaborative filtering and the other is based on content-based filtering. The collaborative filtering has the advantage of "Serendipity" because the items recommended by the content-based filtering become similar and it does not have to use much information but only use a rating history. In this paper, we introduce a recommendation method of collaborative filtering based on association analysis which is one of the data mining techniques. We aim to improve Serendipity keeping Accuracy high by using the evaluation information that are rated differently from a target user. In addition, we show that Accuracy and Serendipity can be adaptable by a parameter in the proposed method. This paper compares the proposed method with a conventional method in terms of the performance of Accuracy and Serendipity.

1:50PM *Investigation of the Effects of Nonverbal Information on Werewolf [#F-14480]*

Daisuke Katagami, Shono Takaku, Michimasa Inaba, Hirotaka Osawa, Kosuke Shinoda, Junji Nishino and Fujio Toriumi, Tokyo Politechnic University, Japan; Hiroshima City University, Japan; University of Tsukuba, Japan; The University of Electro-Communications, Japan; The University of Tokyo, Japan

Werewolf is one of the popular communication games all over the world. It treats ambiguity of human discussion including the utterances, gestures and facial expressions in a broad sense. In this research, we pay attention to this imperfect information game werewolf. The purpose of the research is to develop an intelligent agent "AI werewolf" which is enabled to naturally play werewolf with human. This paper aims to investigate how behavior contribute to victory of own- side players by using machine learning as a first step. As the results of investigation and analysis of the playing movie, we found that

nonverbal information in the game of werewolf has importance to winning or losing the game.

2:10PM *A Study on Extraction of Minority Groups in Questionnaire Data Based on Spectral Clustering [#F-14309]*

Kazuto Inagaki, Tomohiro Yoshikawa and Takeshi Furuhashi, Nagoya University, Japan

In the field of marketing, a questionnaire is one of the most important approaches in order to research the market or to design a marketing strategy. On the other hand, people have a variety of individuality recently, then respondents have various impressions on evaluation objects. In the analysis of collected questionnaire data, it is important not only to analyze overall trends but also to discover minority groups which have strong impressions but are different from general groups. It is, however, difficult to extract minority groups by conventional cluster analysis applied to questionnaire data, because they generally aim at extracting majority groups or making a rough clustering. In this paper, we propose the extraction method of minority groups in questionnaire data using the spectral clustering method which considers local similarity and extracts the clusters having less connection to general groups.

2:30PM *Classification of Writing-Skill Features Using Embodied Expertise Onomatopoeias [#F-14314]*

Hiroki Hojo, Junji Isogai, Tsuyoshi Nakamura, Yutaro Tomoto, Masayoshi Kanoh and Koji Yamada, Nagoya Institute of Technology, Japan; Chukyo University, Japan; Institute of Advanced Media Arts and Sciences, Japan

Embodied expertise, which expresses skills of experts, is a kind of tacit knowledge that is difficult to transferto another person by means of writing it down or verbalizing it. The aim of our study is to translate embodied expertise into explicit knowledge, i.e. onomatopoeias. We call the onomatopoeias "embodied expertise onomatopoeias" which could facilitate people to intuitively and easily understand the skills. Acquiring "embodied expertise onomatopoeias" is considered as a problem of pattern recognition. Our study adopted a skill of Japanese penmanship "Pen Shodo" which is Japanese calligraphy using pen to be translated to onomatopoeias, and investigated a possibility to construct a classification system for the skill.

2:50PM *A Crossover Operation for Evolutionary Binary Decision Diagrams [#F-14318]*

Kai Sugimoto, Tsuyoshi Nakamura and Masayoshi Kanoh, Nagoya Institute of Technology, Japan; Chukyo University, Japan

We propose a crossover operation for multi-terminal decision diagrams (MTBDDs). To survey this crossover operation, we conducted experiments of the evolution of MTBDDs with and without the proposed crossover operation. We confirmed that MTBDDs that have better fitness were obtained in the evolution of MTBDDs with the proposed crossover operation than without it. We also confirmed that MTBDDs that possess the smaller number of vertices were obtained in the evolution of MTBDDs with the proposed crossover operation than without it. than without it.

3:10PM *Robot-Human Interaction to Encourage Voluntary Action [#F-14326]*

Hiroyuki Masuta, Yusei Matsuo, Hun-ok Lim and Naoyuki Kubota, Toyama Prefectural University, Japan; Tokyo Metropolitan University, Japan; Kanagawa University, Japan

This paper discusses robot partner interaction based on Frankl's psychology to encourage a person act voluntarily. Recently, elderly people who live alone in a room is increased. But, it is hoped that the elderly people keep good health. To keep good health for elderly people, a person should act voluntarily and get involved in community events. In Frankl's psychology insists that the meaning of life is required from external stimuli. Frankl's psychology is defined 3 fields of value which are provided from external stimuli. A person can be found the meaning of life according to the values getting. Therefore, it is expected that a person would act voluntarily if a person find the meaning and value of life from external stimuli through interacting with a robot partner. In this research, we propose the robot interaction method based on Frankl's psychology. And we propose an external value estimation method based on the fields of value which estimates an external value from environmental change. Through human-robot interaction experiment based on Frankl's psychology, we verify that a human acts voluntarily by finding the external value.

Special Session: WeF1-2 Methods and Applications of Fuzzy Cognitive Maps

Wednesday, July 9, 1:30PM-3:30PM, Room: 201B, Chair: Engin Yesil and Elpiniki Papageorgiou

1:30PM *Modelling Dynamic Causal Relationship in Fuzzy Cognitive Maps [#F-14185]*

Yuan Miao, Victoria University, Australia

Most applications of Fuzzy Cognitive Maps (FCM) uses static causal links to connect different concepts. However, a causal impact may take effect immediately, or accumulate over a period of time. Consider two cognitive models with a same causal structure, state sets, decision functions and causal linkage strengths, if their causal links have different dynamics, they can have significantly different or even totally different hidden patterns. This paper proposes an easy to use model to represent the dynamics of causal relationships in fuzzy cognitive maps.

1:50PM *Triangular Fuzzy Number Representation of Relations in Fuzzy Cognitive Maps [#F-14192]*

Engin Yesil, Mehmet Furkan Dodurka and Leon Urbas, Istanbul Technical University, Turkey; Technology University of Dresden, Germany

In this paper, the conventional Fuzzy Cognitive Maps (FCMs), which has already achieved success in many fields, are extended by using triangular fuzzy numbers (TFNs). The advantage of FCMs is that they are relatively easy to construct and parameterize and are capable of handling the full range of system feedback structure, including density-dependent effects. However, it is a well-known fact that there are some limitations inherent in FCM, such as lack of adequate capability to handle uncertain information and lack of enough ability to aggregate the information from different sources. Triangular fuzzy numbers which are represented by a triplet has the capacity to represent the uncertain relations between the concepts. In this context, the weight matrix representing the causal relations are enhanced to a fuzzy weight matrix that has TFNs as element. As a result of this improvement, the dynamic reasoning algorithm of the conventional FCM is improved for the use of the proposed novel FCM. The proposed FCM is presented via four simulations and the results are discussed. The results of the simulation study shows how easily the uncertain information can be represented and interpreted by the proposed FCM design methodology.

2:10PM *Analysis of Fuzzy Cognitive Maps with Multi-Step Learning Algorithms in Valuation of Owner-Occupied Homes [#F-14103]*

Katarzyna Poczeta and Alexander Yastrebov, Kielce University of Technology, Poland

In the paper some analysis of multi-step learning algorithms for fuzzy cognitive map (FCM) is given. FCMs, multi-step supervised learning based on gradient method and unsupervised one based on nonlinear Hebbian

learning (NHL) algorithm are described. Comparative analysis of these methods to one-step algorithms, from the point of view of the speed of convergence of learning algorithm and the influence on the decision support system for the valuation of owner-occupied homes was performed. Simulation results were obtained with the use of ISEMK (Intelligent Expert System based on Cognitive Maps) software tool. The results show that the implementation of the multi-step technique gives certain possibilities to get quicker values of target FCM relations and improve the operation of the learned system.

2:30PM *Learning Large-Scale Fuzzy Cognitive Maps Using a Hybrid of Memetic Algorithm and Neural Network [#F-14125]*

Yaxiong Chi and Jing Liu, Xidian University, China

Fuzzy cognitive maps (FCMs) are cognition fuzzy influence graphs, which are based on fuzzy logic and neural network. In this paper, we propose a novel method combining Memetic Algorithms (MAs) and Neural Networks (NNs) to learn large-scale FCMs, which is labeled as MA-NN-FCM. In MA-NN-FCM, MAs are used to determine the regulatory connections in the network from multiple observed response sequences and NNs are used to calculate the interactions between concepts. In the experiments, the performance of MA-NN-FCM is validated on synthetic data with different number of nodes. The experimental results demonstrate the efficiency of our method, and show MA-NN-FCM can construct FCMs with high accuracy without expert knowledge. The performance of MA-NN-FCM is better than that of other FCM learning algorithms, such as ant colony optimization, non-linear Hebbian learning, and real-coded genetic algorithm.

2:50PM *ICLA Imperialist Competitive Learning Algorithm for Fuzzy Cognitive Map [#F-14126]*

Sadra Ahmadi, Somayeh Alizadeh, Nafiseh Forouzideh, Chung-Hsing Yeh, Rodney Martin and Elpiniki Papageorgiou, Monash University, Australia; K.N.Toosi University, Iran; Center for Research and Technology Hellas, Greece

In this paper, we develop a new Fuzzy Cognitive Maps (FCM) learning method using the imperialistic competitive learning algorithm (ICLA). An FCM seems like a fuzzy signed directed graph with feedback, and models complex systems as a collection of concepts and causal relations between concepts. Conventional FCMs are mainly constructed by human experts who have experience in the specific problem domain. However, large problems need automated methods. We develop an automated method for FCM development inspired by the socio-political behavior of countries as imperialists with colonies. In the real world imperialists extend their territories and change the socio attributes of their colonies. The ICLA is an evolutionary algorithm and simulates this behavior. We explain the algorithm for FCM learning and demonstrate its performance advantages. The results of the new algorithm were compared to that of a genetic algorithm, which is the most commonly used and well-known FCM learning algorithm.

3:10PM *Towards a Hybrid Approach of Primitive Cognitive Network Process and Fuzzy Cognitive Map for Box Office Analysis [#F-14160]*

Nicole Yamei Zhou and Kevin Kam Fung Yuen, Xi'an Jiaotong-Liverpool University, China

Box office analysis is critical to make profitable movies. Various factors have different influences on box office sales. This paper combines Primitive Cognitive Network Process (PCNP) and Fuzzy Cognitive Map (FCM) to measure and analyze the factors of box office. PCNP is a revised approach of Analytic Hierarchy Process (AHP) to quantify the weights of factors to construct a concept in FCM. FCM is used to simulate the influences of the concepts in the network. The proposed hybrid approach can enhance the evaluation and. To show the applicability of PCNP-FCM, an example of box office analysis is illustrated

WF1-3 Real World Applications

Wednesday, July 9, 1:30PM-3:30PM, Room: 201C, Chair: Tadanari Taniguchi and Huaguang Zhang

1:30PM *Cooperative and Hierarchical Fuzzy MPC for Building Heating Control [#F-14083]*

Barbara Mayer, Michaela Killian and Martin Kozek, FH JOANNEUM, Austria; Vienna University of Technology, Austria

A combined cooperative and hierarchical control structure utilizing Fuzzy Model Predictive Control (FMPC) for building heating is introduced. The structure comprises three types of Model Predictive Controllers (MPC): For different independent zones of the building FMPCs optimize the fast acting input variable fan coils (FC) while a global linear MPC optimizes the slowly acting thermally activated building systems (TABS). Cooperation between these two groups of controllers is guaranteed by an inter-sample iteration. This cooperative structure acts as master in a hierarchical structure, where the slave is a mixed-inter MPC (MI-MPC) in the supply level.While the cooperative structure ensures user comfort in the building, the MI-MPC optimizes monetary costs of heat supply. This structure allows for decoupled and independent modeling of FMPCs, simple incorporation of the coupling input TABS, and decoupled design of the supply level control. A discussion on stability and sub-optimality of the control structure is given. A simulation of a large office building incorporating disturbances of ambient temperature, radiance, and occupancy demonstrates the performance of the proposed concept.

1:50PM *A Clustering Routing Protocol for Wireless Sensor Networks Based on Type-2 Fuzzy Logic and ACO [#F-14099]*

QiYe Zhang, ZeMing Sun and Feng Zhang, Beihang University, China

Aiming at the problem of load balancing and lifetime prolonging for wireless sensor networks (WSNs), and considering complex uncertainties existed in WSNs, this paper proposes a clustering routing protocol CRT2FLACO for WSN based on type-2 fuzzy logic and ant colony optimization (ACO). Specifically, in the cluster set-up phase, a type-2 Mamdnai fuzzy logic system (T2MFLS) is built to handle rule uncertainty better and balance the network load, in which three important factors---residual energy, the number of neighbor nodes and the distance to the base station (BS) of a node---are considered as inputs, and the probability of the node to be a candidate cluster head (CH) and the CH competition radius as outputs of our T2MFLS, to select the final CHs; in the steady-state phase, in order to reduce the transmission consumption, all the CHs are linked into a chain using ACO algorithm, then each CH send its data packet to the leader along link, which is a CH eventually transmitting packets to the BS. The simulation results show that the proposed routing protocol can effectively balance network load and reduce the transmission energy consumption of CHs, thus greatly prolong the lifetime of WSN.

2:10PM *An Adaptive Interval Type-2 Fuzzy Logic Framework for Classification of Gait Patterns of Anterior Cruciate Ligament Reconstructed Subjects [#F-14297]*

Owais A Malik, S. M. N. Arosha Senanayake and Danish Zaheer, Universiti Brunei Darussalam, Brunei Darussalam; Sports Medicine and Research Centre, Brunei Darussalam

This paper aims to investigate a gait pattern classification system for anterior cruciate ligament reconstructed (ACL-R) subjects based on the interval type-2 fuzzy logic (FL). The proposed system intends to model the uncertainties present in kinematics and electromyography (EMG) data used for gait analysis due to intra- and inter-subject stride-to-stride variability and nature of signals. Four features were selected from kinematics and EMG data recorded through wearable wireless sensors. The parameters for the membership functions of these input features were determined using the data recorded for 12 healthy and ACL-R subjects. The parameters for output membership functions and rules were chosen based on the recommendations from physiotherapists and physiatrists. The system was trained by using steepest descent method and tested for singleton and non-singleton inputs. The overall classification accuracy results show that the interval type-2 FL system outperforms the type-1 FL system in recognizing the gait patterns of healthy and ACL-R subjects.

2:30PM *Fuzzy Chest Pain Assessment for Unstable Angina Based on Braunwald Symptomatic and Obesity Clinical Conditions [#F-14463]*

Thiago Orsi, Ernesto Araujo and Ricardo Simoes, Faculdade de Ciencias Medicas de Minas Gerais, Brazil; Universidade Federal de Sao Paulo and Faculdade de Ciencias Medicas de Minas Gerais, Brazil

A fuzzy medical diagnostic decision system for helping support to evaluate patients with anginal chest pain and obesity clinical condition is proposed in this paper. Such an approach is based on the Braunwald symptomatic classification, the fuzzy set theory and fuzzy logic, and a risk obesity factor determined by a simplified Fuzzy Body Mass Index (FBMI). The fuzzy Braunwald symptomatic classification intertwined with the fuzzy obesity risk factor overwhelm the current rapid access chest pain clinic approaches that do not discriminate the obesity comorbidity or takes into account the subjectiveness, uncertainty, imprecision, and vagueness concerning such a clinical health condition. The resulting fuzzy obesity-based Braunwald symptomatic chest pain assessment is an alternative to support healthcare professionals in primary health care for patients with anginal chest pain worsened by the obesity clinical condition.

2:50PM *Fuzzy Breast Cancer Risk Assessment [#F-14542]*

Aniele C. Ribeiro, Deborha P. Silva, and Ernesto Araujo, Faculdade de Ciencias Medicas de Minas Gerais, Brazil; Universidade Federal de Sao Paulo and Faculdade de Ciencias Medicas de Minas Gerais, Brazil

A breast cancer risk assessment based on fuzzy set theory and fuzzy logic is proposed in this paper. The proposed fuzzy breast cancer system maps two controlled and two non-controlled input variables into the risk of breast cancer occurrence. Such an approach covers the age, menopause, simplified fuzzy body mass index (FBMI), and the existence of hormonal reposition as input linguistic variable. The risk of a woman developing breast cancer is the outcome of the proposed fuzzy breast cancer risk analysis. The resulting fuzzy breast cancer diagnostic decision system for helping support to evaluate patients with such a clinical condition is an alternative to support healthcare professionals in such a complex health diagnosis.

3:10PM *Long Term Prediction for Generation Amount of Converter Gas Based on Steelmaking Production Status Estimation [#F-14372]*

Xiaoyan Tang, Jun Zhao, Chunyang Sheng and Wei Wang, Dalian University of Technology, China

Long term prediction for generation amount of Converter gas is very important for the optimal scheduling of energy system in iron and steel making enterprises. In this paper, a long term prediction approach based on steelmaking production status estimation is proposed to address this issue. Steelmaking production status estimation has two stages, namely feature extraction and feature fusion. At the first stage, the generation time series of Converter gas is divided into some data segments with the same length, and then a method based on template matching is used to extract the time and frequency domain characteristics of steelmaking production status. At the second stage, an improved version of fuzzy C-mean clustering method is developed for feature fusion, which integrates the characteristics from different data segments to obtain a universal feature of steelmaking production status. Finally, the universal feature is used to reconstruct the generation time series of Converter gas. To verify the effectiveness of the proposed method for long term generation amount prediction of Converter gas, a set of experiments is conducted based on the real world data from an iron and steel enterprise. The experimental results demonstrate that the proposed method exhibits high accuracy and can provide an effective guidance for balancing and scheduling the byproduct Converter gas

WeF1-4 Fuzzy Pattern Recognition & Image Processing

Wednesday, July 9, 1:30PM-3:30PM, Room: 201D, Chair: Dongbin Zhao and Isao Hayashi

1:30PM *Fuzzy Classification of Orchard Pest Posture Based on Zernike Moments [#F-14135]*

Wenyong Li, Shangfeng Du, Meixiang Chen, Ming Li and Chuanheng Sun, China Agricultural University, China; National Engineering Research Center for Information Technology in Agriculture, China

Identification and count of orchard pests is very important in monitoring orchard pest population. The pests trapped by high-voltage grid show different postures and incomplete bodies, which increase the difficulty of image automated identification. Currently, most researches of pest image identification focus on feature extraction based on standard posture samples, without considering the influence from multi-pose of pests in natural scene. Consequently, the identification rates of these methods are low in practical orchard application. Using Dichocrocis punctiferalis (Guenee) as research object, this paper is directed towards a posture classification method for the orchard target pest identification. It aims at intensifying the performance of multi-pose pest identification system by utilizing Zernike moments as descriptors of shape characteristics. The input image is cropped automatically and further subjected to a number of preprocessing stages. The outcome of preprocessing stage is one processed image containing scaled and translated target pest. Then, the template number is determined according to the posture of target pest and the corresponding template parameters are obtained from the cluster centers by fuzzy C-mean clustering method. Experiment results show that the proposed shape feature is robust to changes caused by pest image shape rotation, translation, and/or scaling. And the highest accuracy of posture classification is 92.3% for orchard target pest Dichocrocis punctiferalis (Guenee) with multiple postures. It outperforms the method in reference where the highest accuracy is 86.6%.

1:50PM *Fuzzy Measures of Pixel Cluster Compactness [#F-14343]*

Gleb Beliakov, Gang Li, Quan Vu and Tim Wilkin, Deakin University, Australia

Pixel-scale fine details are often lost during image processing tasks such as image reduction and filtering. Block or region based algorithms typically rely

on averaging functions to implement the required operation and traditional function choices struggle to preserve small, spatially cohesive clusters of pixels which may be corrupted by noise. This article proposes the construction of fuzzy measures of cluster compactness to account for the spatial organisation of pixels. We present two construction methods (minimum spanning trees and fuzzy measure decomposition) to generate measures with specific properties: monotonicity with respect to cluster size; invariance with respect to translation, reflection and rotation; and, discrimination between pixel sets of fixed cardinality with different spatial arrangements. We apply these measures within a non-monotonic mode-like averaging function used for image reduction and we show that this new function preserves pixel-scale structures better than existing monotonic averages.

2:10PM *Image Composition Using F-Transform [#F-14352]*

Marek Vajgl, Petr Hurtik, Irina Perfilieva and Petra Hodakova, University of Ostrava, Czech Republic

The contribution describes newly developed technique used to improve image quality by fusion of information from the multiple images into one resulting image containing better information than each of the input ones. The presented approach is based on the F-Transform, integral transform used to detect gradients, similarity and image fusion, and noise reduction.

2:30PM *Fusion of Multi-Spectral and Panchromatic Satellite Images Using Principal Component Analysis and Fuzzy Logic [#F-14517]*

Reham Gharbia, Ali Hassan El Baz, Aboul Ella Hassanien, Gerald Schaefer, Tomoharu Nakashima and Ahmad Taher Azar, Nuclear Materials Authority, Egypt; Damietta University, Egypt; Cairo University, Egypt; Loughborough University, United Kingdom; Osaka Prefecture University, Japan; Benha University, Egypt

In this paper, we propose a fuzzy-based multi-spectral (MS) and panchromatic (PAN) image fusion approach which provides a tradeoff solution between spectral and spatial fidelity and is able to preserve more detail in terms of spectral and spatial information. First, we perform principal component analysis on the multi-spectral images and utilise the first principal component to extract matched low and high frequency coefficients. We then apply fuzzy-based image fusion rules to fuse the first principal component with the PAN image, followed by fusing the approximation coefficients. The proposed approach is tested on several satellite images and shown to provide a feasible and effective approach.

2:50PM *Structural Classification of Proteins through Amino Acid Sequence Using Interval Type-2 Fuzzy Logic System [#F-14324]*

Thanh Nguyen, Abbas Khosravi, Douglas Creighton and Saeid Nahavandi, Deakin University, Australia

This paper introduces a new multi-output interval type-2 fuzzy logic system (MOIT2FLS) that is automatically constructed from unsupervised data clustering method and trained using heuristic genetic algorithm for a protein secondary structure classification. Three structure classes are distinguished including helix, strand (sheet) and coil which correspond to three outputs of the MOIT2FLS. Quantitative properties of amino acids are used to characterize the twenty amino acids rather than the widely used computationally expensive binary encoding scheme. Amino acid sequences are parsed into learnable patterns using a local moving window strategy. Three clustering tasks are performed using the adaptive vector quantization method to derive an equal number of initial rules for each type of secondary structure. Genetic algorithm is applied to optimally adjust parameters of the MOIT2FLS with the purpose of maximizing the Q3 measure. Comprehensive experimental results demonstrate the strong superiority of the proposed approach over the traditional methods including Chou-Fasman method, Garnier-Osguthorpe-Robson method, and artificial neural network models.

3:10PM *A Hybrid Type-2 Fuzzy Clustering Technique for Input Data Preprocessing of Classification Algorithms [#F-14489]*

Vahid Nouri, Mohammad-R Akbarzadeh-T and Alireza Rowhanimanesh, Islamic Azad University, Iran; University of Neyshabur, Iran

Recently, clustering has been used for preprocessing datasets before applying classification algorithms in order to enhance classification efficiency. A strong clustered dataset as input to classification algorithms can significantly improve computation time. This can be particularly useful in Big Data where computation time is equally or more important than accuracy. However, there is a trade-off between speed and accuracy among clustering algorithms. Specifically, general type-2 fuzzy c-means (GT2 FCM) is considered to be a highly accurate clustering approach, but it is computationally intensive. To improve its computation time we propose here a hybrid clustering algorithm called KGT2FCM that combines GT2 FCM with a fast k-means algorithm for input data preprocessing of classification algorithms. The proposed algorithm shows improved computation time when compared with GT2 FCM as well as KFGT2FCM on five benchmarks from UCI library.

WeI1-1 Intel Special Session on Big Data Analytics

Wednesday, July 9, 1:30PM-3:30PM, Room: 311A, Chair: Catherine Huang

1:30PM *Practice in Analyzing Corporate Textual Data*

Phil Tian, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

1:50PM *Intel Hadoop and Its Use Cases*

Keith Qi, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:10PM *Big Data Foundation Platform for Video Analytics*

Albert Hu, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:30PM *Cloud based Air Quality Monitoring at Scale*

Fred Jiang, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:50PM *Big Data Foundation Platform for Video Analytics Demo*

Albert Hu, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

3:10PM *Cloud based Air Quality Monitoring at Scale Demo [#F-14559]*
Fred Jiang, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

Wednesday, July 9, 3:30PM-6:00PM

Poster Session: PF3 Fuzzy Theory & Decision Making

Wednesday, July 9, 3:30PM-6:00PM, Room: Posters Area (Level 2), Chair: Christian Mayr and Anca Croitoru

P501 *On the Cross-Migrativity of Triangular Subnorms [#F-14031]*
Hangdan Wang and Qin Feng, Jiangxi Normal University, China

In this paper, the sufficient and necessary conditions that a triangular subnorm M is (\alpha,T)-cross-migrative are given out, where T stands for any of the three prototype triangular norms, that is, T\in \{T_P,\ T_M,\ T_L\}, M is a triangular subnorm with a continuously additive generator. By comparison with results of the (\alpha,T)-cross-migrativity of triangular norms obtained by Fodor, it is in some sense that they are compatible.

P502 *A Fast Geometric Defuzzication Algorithm for Large Scale Information Retrieval [#F-14095]*
Simon Coupland, David Croft and Stephen Brown, De Montfort University, United Kingdom

In this paper we explore the centroid defuzzication operation in the context of specific data retrieval application. We present a novel implication and centroid defuzzication approach based on geometric fuzzy sets and systems. It is demonstrated that this new approach requires fewer operations and results in a significant reduction in processing time in our application.

P503 *A Novel Algorithm to Solve the Minimal Hitting Sets in MBD [#F-14235]*
Jianfang Xu, Zhigang Liu and Chenxi Dai, Southwest Jiaotong University, China

Although the advantages of model-based fault diagnosis are becoming more and more obvious in system fault diagnosis, the computation efficiency of minimal hitting sets is the main bottleneck. To improve the calculating speed of existed algorithms and solve the problem of incomplete minimal hitting sets, this paper proposes an improved differential evolution algorithm. Introduction of binary to differential evolution algorithm. The new method takes advantage of the rapid differential evolution algorithm, and adds the minimal assurance strategy to hitting sets in the evolutionary process. Accordingly, the computational efficiency and accuracy of minimal hitting sets are guaranteed. The algorithm is used in the classical digital circuits and traction substation fault diagnosis, and the simulation results show that the speed and accuracy of calculation minimal hitting set is improved. And the efficiency of model-based fault diagnosis is enhanced. In addition, the algorithm can be widely applied to all kinds of system or element fault diagnosis.

P504 *Fuzzy Linguistic First Order Logic Based on Refined Hedge Algebra [#F-14262]*
Duc Khanh Tran and Minh Tam Nguyen, Vietnamese-German University, Viet Nam; Vinh University, Viet Nam

We present a fuzzy linguistic first order logic having the truth domain as a refined hedge algebra. The syntax and se- mantic are defined. Resolution is chosen for the inference system. To capture the approximate nature of resolution inferences, the notion of reliability of resolution inferences is defined. In this respect the resolution procedure can not only prove facts but also indicate how reliable the proof is. We prove the soundness and completeness of the resolution procedure using semantic tree technique.

P505 *Bayesian Games with Ambiguous Type Players [#F-14087]*
Youzhi Zhang, Xudong Luo, Wenjun Ma and Ho-fung Leung, Sun Yat-sen University, China; Queen's University Belfast, United Kingdom; The Chinese University of Hong Kong, Hong Kong

Bayesian games can handle the incomplete information about players' types. However, in real life, the information could be not only incomplete but also ambiguous for lack of sufficient evidence, i.e., a player cannot have a probability precisely about each type of the other players. To address this issue, we extend the Bayesian games to ambiguous Bayesian games. We also illustrate and analyse our game model.

P506 *Clustering Based Outlier Detection in Fuzzy SVM [#F-14121]*
Rahul Kumar Sevakula and Nishchal Kumar Verma, Indian Institute of Technology Kanpur, India

Fuzzy Support Vector Machine (FSVM) has become a handy tool for many classification problems. FSVM provides flexibility of incorporating membership values to individual training samples. Performance of FSVM largely depends on how well these membership values are assigned to the training samples. Recently, a new approach for assigning membership values was proposed, where only possible outliers are allowed to have membership value lower than '1'. For doing the same, first DBSCAN clustering is performed to find the set of possible outliers and such possible outliers were then assigned membership values based on some heuristics. All other remaining samples were assigned a membership value of '1'. This paper extends the same approach by further analyzing the algorithm, introducing Fuzzy C- Means clustering based heuristic for assigning membership values and also comparing two methods of finding optimal parameters for FSVM model. Experiments have been performed over 4 real world datasets for comparing and analyzing the different methods.

P507 *Situation-Based Allocation of Medical Supplies in Unconventional Disasters with Fuzzy Triangular Values [#F-14360]*
Junhu Ruan and Yan Shi, Dalian University of Technology, China; Tokai University, Japan

Prompt medical service and supplies are very important to reduce the life loss in response to disasters. In the work, we focus on how to allocate the limited medical supplies to affected areas in different situations with fuzzy triangular values. Using the alfa-cut method and Giove's acceptability index, we first propose a method of comparing fuzzy triangular numbers. Then, based on our previous work, we develop a situation-based approach for allocating medical supplies with fuzzy triangular values. A simple example shows the effectiveness of the developed approach.

P508 *Novel Hierarchical Fault Diagnosis Approach for Smart Power Grid with Information Fusion of Multi-Data Resources Based on Fuzzy Petri Net [#F-14393]*

Yingnan Wang, Jinfeng Ye, Guojun Xu, Qingmiao Chen, Haiyang Li and Xinrui Liu, Shenyang Power Supply Company, China; Northeastern University, China; Dandong Power Supply Company, China

Considering the problem of the complicated structure of smart power grid, the varied topology after fault and multi-data resources of fault information, this paper presents a novel hierarchical fault diagnosis approach for smart power grid with information fusion of multi-data resources, which contains diagnosis layers of the switch and the information fusion of multi-data. In the diagnosis layer of switch, the network topology is established based on the information provided by the SCADA system. In the diagnosis layer of the information fusion of multi-data, a smart power grid fault-diagnosis method of directional weighted fuzzy petri nets using the diagnosis information from fault recorder and WAMS is presented, which considering the information of protection and circuit breaker. Then fault diagnosis is conducted information fusion with the improved D-S evidence theory. Finally, the diagnostic decision is obtained with C-means algorithm. The simulation shows that the method has good adaptability, and in the case of incomplete information, the method can still obtain correct diagnosis results, and has certain universality and fault tolerance ability.

P509 *A New Approach to Improve the Consistency of Linguistic Pair-Wise Comparison Matrix and Derive Interval Weight Vector [#F-14401]*

Hengshan Zhang, Qinghua Zheng, Ting Liu and Yan Nan, Xian Jiaotong University, China

H. Zhang, Q. Zheng, and T. Liu et al. proposed a discrete region based approach to improve the consistency of the pair-wise comparison matrix. The approach is able to significantly improve the consistency of pair-wise comparison matrix without to revise the decision maker's opinion. In the approach, a discrete region matrix is transformed into a set-matrix in which the elements are the real number set. In this paper, a discrete region matrix is transformed into a reciprocal interval matrix. A new iterative searching algorithm (NISA) is proposed to find the pair-wise comparison matrix with approximate optimum consistency from the reciprocal interval matrix. Based on the similarly principle, a new algorithm is proposed to derive the interval weight vector for the reciprocal interval matrix. The key character of this algorithm is that the derived interval weight vector includes the weight vector got by NISA for the same reciprocal interval matrix. In the experiment, five experimental strategies are designed, and the experimental results show that H. Zhang et al. proposed approach and NISA can get approximately similar weight vector according to the same pair-wise comparison matrix used the discrete region.

P510 *Collaborative Diagnosis through Fuzzy Petri Net Based Agent Argumentation [#F-14536]*

Xuehong Tao, Yuan Miao, Yanchun Zhang and Zhiqi Shen, Victoria University, Australia; Nanyang Technological University, Singapore

Online health information services and self diagnosis systems become popular recent years. We propose a computing model for collaborative medical diagnosis through multi agent argumentation. In this model, the agents are able to communicate with each other to share information, critique and verify each other's knowledge, and collaboratively make diagnosis based on multiple agents' knowledge through an argumentation process. Fuzzy Petri Net (FPN) is adopted as the agents' knowledge model. Different from the commonly used FPNs that assign tokens in places, we assign tokens on arcs and also give places capability in controlling the inference of FPN. The FPN based argumentation is automated with algorithms. The proposed model can be employed to achieve collaborative healthcare diagnosis systems, where agents with different expertise collaboratively argue with each other to come up with a mutually agreed diagnosis.

P511 *Estimations, Convergences and Comparisons on Fuzzy Integrals of Sugeno, Choquet and Gould Type [#F-14107]*

Anca Croitoru and Nikos Mastorakis, Al. I. Cuza University, Romania; Technical University of Sofia, Bulgaria

The subject of this paper concerns fuzzy integrals and fuzzy convergences. The first topic consists of presenting some relationships among different types of integrals of multifunctions relative to a fuzzy measure such as the strong and the weak Sugeno type integrals, the Aumann-Gould integral and the Dunford integral. A new estimation result on the strong integral is also established. Secondly, we present new connections among different types of integrals of real functions relative to a fuzzy measure such as the Gould integral, the Birkhoff integral, the Choquet integral and the non-linear integrals. Then we focus on establishing new links among different types of fuzzy convergences for sequences of multifunctions with respect to a fuzzy (or a non-additive) measure such as almost everywhere convergence, pseudo-almost everywhere convergence, almost uniformly convergence, pseudo-almost uniformly convergence, mean convergence and convergence in measure. In the end, we emphasize some applications of fuzzy integrals and fuzzy convergences, for example, in accident rate predictions, in subjective evaluations etc.

P512 *An Approach to Covering-Based Rough Sets through Bipartite Graphs [#F-14210]*

Jingqian Wang and William Zhu, Minnan Normal University, China

Covering is an important form of data, and covering-based rough sets provide an effective tool to deal with this data. In this paper, we use bipartite graphs to study covering-based rough sets. Firstly, a bipartite graph is constructed through a covering, named bipartite graph associated with a covering. According to a bipartite graph associated with a covering, two equivalent representations of a pair of covering approximation operators are presented. Then, some properties of this pair of covering approximation operators and reducible elements in a covering are investigated through the constructed bipartite graph. In a word, these results show an interesting view of graphs to investigate covering-based rough sets.

P513 *A Generalized Equilibrium Value-Based Approach for Solving Fuzzy Programming Problem [#F-14250]*

Chenxia Jin, Yan Shi, Meng Yang and Fachao Li, Hebei University of Science and Technology, China; Tokai University, Japan

Fuzzy programming approach has wide application in many fields such as project management, multi-attribute decision making, and comprehensive evaluation. Its solving methods have attracted many attentions. In this paper we present a new approach, based on the genetic algorithm, for dealing with a programming problem with fuzzy-valued objective function and constraints. Firstly, we propose the concept of generalized equilibrium value of fuzzy number, and analyze the properties, further give the operation rules; secondly, we establish a generalized equilibrium value-based fuzzy programming method combined with genetic algorithm; finally, we analyze the characteristic of the above mentioned method through a non-linear fuzzy programming problems.

P514 *On Three Types of Covering-Based Rough Sets via Definable Sets [#F-14263]*

Yanfang Liu and William Zhu, Minnan Normal University, China

The study of definable sets in various generalized rough set models would provide better understanding to these models. Some algebraic structures of all definable sets have been investigated, and the relationships among the definable sets, the inner definable sets and the outer definable sets have been presented. In this paper, we further study the definable sets in three

types of covering- based rough sets and present several necessary and sufficient conditions of definable sets. These three types of covering-based rough sets are based on three kinds of neighborhoods: the neighborhood, the complementary neighborhood and the indiscernible neighborhood, respectively. Some necessary and sufficient conditions of definable sets are presented through these three types of neighborhoods, and the relationships among the definable sets are investigated. Moreover, we study the relationships among these three types of neighborhoods, and present certain conditions that the union of the neighborhood and the complementary neighborhood is equal to the indiscernible neighborhood.

P515 *Multi-Agent Evolutionary Design of Beta Fuzzy Systems [#F-14298]*

Yosra Jarraya, Souhir Bouaziz, Adel M. Alimi and Ajith Abraham, National School of Engineers, Tunisia; Technical University of Ostrava, Czech Republic

This paper provides an overview on a new evolutionary approach based on an intelligent multi-agent architecture to design Beta fuzzy systems (BFSs). The Methodology consists of two processes, a learning process using a clustering technique for the automated design of an initial Beta fuzzy system, and a multi- agent tuning process based on Particle Swarm Optimization algorithm to deal with the optimization of membership functions parameters and rule base. In this approach, dynamic agents use communication and interaction concepts to generate high-performance fuzzy systems. Experiments on several data sets were performed to show the effectiveness of the proposed method in terms of accuracy and convergence speed.

P516 *T-S Fuzzy Affine Linear Modeling Algorithm by Possibilistic C-Regression Models Clustering Algorithm [#F-14361]*

Chung-Chun Kung and Hong-Chi Ku, University of Tatung, Taiwan

This paper presents a Takagi-Sugeno (T-S) fuzzy affine linear modeling algorithm by the possibilistic c-regression models (PCRM) clustering algorithm. We apply the PCRM clustering algorithm to partition the given input-output data into hyper-plane-shaped clusters (regression models). We choose the suitable number of cluster by the cluster validity criterion and then to construct the T-S fuzzy affine linear model. A simulation example is provided to demonstrate the accuracy and effectiveness of the T-S fuzzy affine linear modeling algorithm.

P517 *An Under-Sampling Method Based on Fuzzy Logic for Large Imbalanced Dataset [#F-14365]*

Ginny Y. Wong, Frank H. F. Leung and Sai-Ho Ling, Hong Kong Polytechnic University, Hong Kong; University of Technology Sydney, Australia

Large imbalanced datasets have introduced dif- ficulties to classification problems. They cause a high error rate of the minority class samples and a long training time of the classification model. Therefore, re- sampling and data size reduction have become important steps to pre-process the data. In this paper, a sampling strategy over a large imbalanced dataset is proposed, in which the samples of the larger class are selected based on fuzzy logic. To further reduce the data size, the evolutionary computational method of CHC is employed. The evaluation is done by applying a Support Vector Machine (SVM) to train a classification model from the re-sampled training sets. From experimental results, it can be seen that our proposed method improves both the F-measure and AUC. The complexity of the classification model is also compared. It is found that our proposed method is superior to all other compared methods.

P518 *A Differential Evolution Based Adaptive Neural Type-2Fuzzy Inference System for Classification of Motor Imagery EEG Signals [#F-14538]*

Debabrota Basu, Saugat Bhattacharyya, Dwaipayan Sardar, Amit Konar, D.N. Tibarewala and Atulya Nagar, Jadavpur University, India; Liverpool Hope University, United Kingdom

This paper proposes a new classification algorithm which aims at predicting different states from an incoming non-stationary signal. To overcome the failure of standard classifiers at generalizing the patterns for such signals, we have proposed an Interval Type-2 Fuzzy based Adaptive neural fuzzy Inference System (ANFIS). Through the introduction IT2F system, we have aimed at improving the uncertainty management of the fuzzy inference system. Besides that using DE in forward and backward pass and improving the forward pass function we have improved the parameter update on wide range of nodal functions without any quadratic approximation in forward pass. The proposed algorithm is tested on a standard EEG dataset and it is noted that the proposed algorithm performs better than other standard classifiers including the classical ANFIS algorithm.

P519 *Construction of Slope-Consistent Trapezoidal Interval Type-2 Fuzzy Sets for Simplifying the Perceptual Reasoning Method [#F-14153]*

Chengdong Li, Jianqiang Yi, Guiqing Zhang and Ming Wang, Shandong Jianzhu University, China; Institute of Automation, Chinese Academy of Sciences, China

Computing with words (CWW) proposed by Zadeh is an useful paradigm to mimic the human decision-making ability in a wide variety of physical and mental tasks. To realize CWW, Mendel proposed a specific architecture called perceptual computer, in which interval type-2 (IT2) fuzzy sets (FSs) and perceptual reasoning (PR) method are adopted. The PR method has been proved to have good properties (e.g. it can output intuitive IT2 FSs) and has found several applications in decision making. In this study, we focus on simplifying this method by avoiding its \alpha-cuts based inference process. We first present a novel property for the inference of the PR method. We observe from the property that, if the IT2 FSs in the consequents of the IF-THEN rules are trapezoidal and have consistent slopes, then the output IT2 FS will be strictly trapezoidal and can be determined easily. In this case, the computation of the PR method can be simplified. To achieve such simplification, the trapezoidal IT2 FSs without consistent slopes should be approximated by the slope-consistent trapezoidal IT2 FSs. This issue is also studied in this paper by solving the constrained linear- quadratic optimization problem. At last, examples are given. The simplified PR method will be useful when the CWW models are utilized in the modeling and/or control problems of complex systems or multivariable dynamic systems.

Wednesday, July 9, 4:00PM-6:00PM

Special Session: WeF2-1 Human Symbiotic Systems II

Wednesday, July 9, 4:00PM-6:00PM, Room: 201A, Chair: Daisuke Katagami

4:00PM *Effect of Robot Utterances Using Onomatopoeia on Collaborative Learning [#F-14336]*

Felix Jimenez, Masayoshi Kanoh, Tomohiro Yoshikawa, Takeshi Furuhashi and Tsuyoshi Nakamura, Chukyo University, Japan; Nagoya University, Japan; Nagoya Institute of Technology, Japan

We investigated the effect of robot's utterances using onomatopoeia on collaborative learning. The robot was designed to praise or comfort by using onomatopoeia when learners are given problem to solve through a learning system. When learners can correctly solve a problem, the robot praises the learner's success. When learners cannot solve it, the robot comforts the learners to keep working at it. Eight college students learns mathematics by using a learning system with a robot for three weeks and took exams. We found that a robot could comfort learners that used onomatopoeia more than a robot that did not use onomatopoeia. This suggests that the robot that praises or comforts by using onomatopoeia helps learners maintain their motivation in collaborative learning.

4:20PM *Behavior Extraction from Tweets Using Character N-Gram Models [#F-14386]*

Yuji Yano, Tomonori Hashiyama, Junko Ichino and Shun'ichi Tano, The University of Electro-Communications, Japan

Human daily activities are stored in various kinds of data representations using ICT devices nowadays, named lifelogs. It is highly requested to retrieve useful information from lifelogs because these raw data are hard to handle. Extracting human activities from these logs is promising to enrich our life. Context-awareness services can be provided depending on user activities extracted from these logs. Recently, a lot of people post a message called tweet within Twitter to show what they are doing, thinking, feeling, and so on. Tweets have potential to record human activities, because many people post tweets so frequently every day. This paper focused on the tweets to retrieve human behavior from them. The length of tweets are limited within short sentence, so this causes some difficulties. The users will use domain-specific terms and will post grammatically incorrect sentences to fit with the constraints. These make us hard to analyze tweets with grammatical manner or with dictionaries. To tackle them, we are applying character n-gram tokenization and naive Bayes classifier to extract appropriate behavioral information from tweets. Using n-gram tokenizer, domain-specific words can be identified and incorrect grammar can be handled. Our approach is examined using real tweets in Japanese. The index of precision, recall and F-measure shows the promising results. Some experiments have been carried out to show the feasibility of our approach. At this point, our system applied to Japanese tweets but it is applicable to any other languages.

4:40PM *Saliency Map for Visual Attention Region Prediction Based on Fuzzy Neural Network [#F-14407]*

Mao Wang, Yoichiro Maeda and Yasutake Takahashi, University of Fukui, Japan; Osaka Institute of Technology, Japan

Visual attention region prediction has been paid much attention by researchers in intelligent systems recent years because it can make the interaction between human and intelligent agents to be more convenient. In this paper, the prediction method of the visual attention region inferred by using fuzzy neural network (FNN) after extracting and computing of images feature maps and saliency maps was proposed. A method for training FNN is also proposed. A user experiment was conducted to evaluate the prediction effect of proposed method by making surveys for the prediction results. The results indicated that prediction method proposed by us has a better performance in the level of attention regions' position prediction according to different images.

5:00PM *Melody Oriented Interactive Chaotic Sound Generation System Using Music Conductor Gesture [#F-14433]*

Shuai Chen, Yoichiro Maeda and Yasutake Takahashi, University of Fukui, Japan; Osaka Institute of Technology, Japan

In the research of interactive music generation, we propose a music generation method, that the computer generates the music, under the recognition of human music conductor's gestures. In this research, the generated music is tuned by the recognized gestures for the parameters of the network of chaotic elements in realtime. To make outcomes more closer to music, a different method is proposed to make melody specifiable. Music theories are embedded in the algorithm, as a result, the generated music will be richer. Furthermore, we reconstructed the music generation system and performed the experiment for generating the music composed by human.

5:20PM *Intention Recognition by Inverted Two-Wheeled Mobile Robot through Interactive Operation [#F-14237]*

Yasutake Takahashi, Takuya Inoue and Nakamura Takayuki, University of Fukui, Japan; Wakayama University, Japan

Recently, two-wheeled inverted pendulum mobile robots have been popular. They support human locomotion and/or small goods transportation based on inverted pendulum upright controllers. The conventional inverted pendulum mobile robot controls to follow the fixed desired posture angle and wheel velocity. It is desirable to change the control parameters according to the user intention in order to offer comfortable operability of the robot. This paper proposes a user intention recognition system for a inverted pendulum mobile robot and shows experimental results.

5:40PM *Development of Facial Expression Recognition for Training Video Customer Service Representatives [#F-14504]*

Linh Tuan Dang, Eric W. Cooper and Katsuari Kamei, Ritsumeikan University, Japan

This paper describes a study of the relation between facial expression and customer feeling about service quality. Based on the results, a facial expression warning system will be designed to improve the service quality of the Customer Service Representative when they practice in training sessions. The system, based on existing systems, has three modules: facial recognition, feature extraction and facial expression recognition. This paper also uses Haar-like features for face detection and a Support Vector Machine for facial expression recognition in an attempt to improve the recognition rate by using a novel feature extraction method. This paper also presents results of the method when tested on standard facial expression databases.

Special Session: WeF2-2 Modalities of Fuzzy Signatures in Knowledge Representation

Wednesday, July 9, 4:00PM-6:00PM, Room: 201B, Chair: Laszlo Koczy, Sukanya Manna and Tom Gedeon

4:00PM *On the Development of Signatures for Artificial Intelligence Applications [#F-14172]*
Claudiu Pozna, Radu-Emil Precup, Peter Foldesi and Laszlo Koczy, Szechenyi Istvan University, Hungary; Politehnica University of Timisoara, Romania

This paper illustrates developments of signatures for Artificial Intelligence (AI) applications. Since the signatures are data structures with efficient results in modeling of fuzzy inference systems and of uncertain expert systems, the paper starts with the analysis of the data structures used in AI applications from the knowledge representation and manipulation point of view. An overview on the signatures, on the operators on signatures and on classes of signatures is next given. Using the proto fuzzy inference system, these operators are applied in a new application of fuzzy inference system modeled by means of signatures and of classes of signatures.

4:20PM *A Price Prediction Model for Online Auctions Using Fuzzy Reasoning Techniques [#F-14208]*
Preetinder Kaur, Madhu Goyal and Jie Lu, University of Technology, Australia

E-consumers are urged to opt for the best bidding strategies to excel in the competitive environment of multiple and simultaneous online auctions for same or similar items. It becomes very complicated for the bidders to make the decisions of selecting which auction to participate in, place single or multiple bids, early or late bidding and how much to bid. In this paper, we present the design of an autonomous dynamic bidding agent (ADBA) that makes these decisions on behalf of the buyers according to their bidding behaviors. The agent develops a comprehensive methodology for initial price estimation and an integrated model for final price prediction. The initial price estimation methodology selects an auction to participate in and assesses the value (initial price) of the auctioned item. Then the final price prediction model forecasts the bid amount by designing different bidding strategies using fuzzy reasoning techniques. The experimental results demonstrated improved initial price prediction outcomes by proposing a clustering based approach. Also, the results show the proficiency of the fuzzy bidding strategies in terms of their success rate and expected utility.

4:40PM *OWA-Based Fuzzy Rule Interpolation for Group Decision Making [#F-14418]*
Chengyuan Chen and Qiang Shen, Aberystwyth University, United Kingdom

The goal in group decision making is to ensure that the best decision is made with respect to the available information and knowledge possessed by all group members. However, different types of uncertainty may influence both the assessment of the individual views and the derivation of the overall group- level solution. The difficulty in such decision-making may escalate if the views of all individuals only cover part of the problem space. Systems capable of reasoning through fuzzy interpolation can help. Fuzzy rule interpolation is an important technique for performing inference with sparse rule bases. Even when a given observation has no overlap with the antecedent values of any existing rules, fuzzy rule interpolation may still derive a conclusion. This paper presents an approach for achieving group decision making via fuzzy interpolation. Individual preferences are firstly aggregated by means of a method learned on rough-fuzzy set theory, and rough-fuzzy interpolation is then applied to derive the group-level conclusion. Experimental investigations are carried out and the results are presented to demonstrate the efficacy of the proposed work in guaranteeing the overall decision accuracy.

5:00PM *Sensitivity Analysis of the Weighted Generalized Mean Aggregation Operator and Its Application to Fuzzy Signatures [#F-14438]*
Istvan Harmati, Adam Bukovics and Laszlo Koczy, Szechenyi Istvan University, Hungary

In this paper we give bounds on the changing of the weighted generalized mean in terms of vector norms of the changing of the variables. Applying this result we characterize the sensitivity of fuzzy signatures which equipped with weighted generalized mean operators in their nodes. Finally, a pratical example from civil engineering is also examined.

5:20PM *Understanding Early Childhood Obesity Risks: An Empirical Study Using Fuzzy Signatures [#F-14467]*
Sukanya Manna and Abigail M. Jewkes, California State Polytechnic University, United States

Childhood obesity is a serious health problem that has adverse and long-lasting consequences for individuals, families, and communities. The magnitude of the problem has increased dramatically during the last three decades and, despite some indications of a plateau in this growth, the numbers remain stubbornly high. The nature of child obesity data is very complicated with different factors dependent on each other directly or indirectly affecting obesity as a whole. Traditional statistical analysis and machine learning approaches alone are not sufficient to model early childhood obesity risk and its impact on children's motor development. In this paper, we propose a computational model using Fuzzy Signature to understand and handle the intricacies of child obesity data and propose a solution that could be used to handle the risk associated with early childhood obesity and young children's motor development.

5:40PM *A New Fuzzy Graph and Signature Based Approach to Describe Fuzzy Situational Maps [#F-14501]*
Aron Ballagi, Claudiu Pozna and Laszlo Koczy, Szechenyi Istvan University, Hungary

Computational tasks involving intelligent agents often need to process complex structured information. The way of describing this information greatly influences the performance of the agent. Therefore, a big issue is how the complex data describing that valuable information is not lose while it can also be processed in tractable time. Fuzzy signatures and their multidimensional geometric extension, fuzzy situational maps, are used to describe such complex structured data. These problems are examined in the context of a cooperative mobile robot task and a new method is developed for the simplified describing and processing of the complex inner relations in fuzzy situational maps. This paper mainly deals with the fundamentals of this method.

WeF2-3 Hybrid Fuzzy Systems

Wednesday, July 9, 4:00PM-6:00PM, Room: 201C, Chair: Scott Dick and Chiew Foong Kwong

4:00PM *Oil Spill Trajectory Tracking Using Swarm Intelligence and Hybrid Fuzzy System [#F-14088]*
Mohsen Pashna, Rubiyah Yusof and Rasoul Rahmani, Universiti Teknologi Malaysia, Malaysia

Increase of the offshore industrial activities is highly affecting marine milieu. For example, discharge of liquid petroleum on water surface, oil spill, frequently happens because of the offshore well vessels failure or transportation accidents. Numerous occurrences of the oil spills are obvious examples of affecting ecology by industrialization. Therefore, information about the exact location and real-time situation of an oil spill can significantly facilitate to plan for diminishing the spot, in time. This research proposes a hybrid fuzzy algorithm for individuals of swarm robots, in order to track the boundaries of a simulated oil spill which is influenced by environmental factors such as wind and wave currents. Simulation results prove the feasibility of engaging swarm robotics in this application.

4:20PM *Generating Interpretable Mamdani-Type Fuzzy Rules Using a Neuro-Fuzzy System Based on Radial Basis Functions [#F-14338]*

Diego G. Rodrigues, Gabriel Moura, Carlos M. C. Jacinto, Paulo Jose de Freitas Filho and Mauro Roisenberg, Federal University of Santa Catarina, Brazil; Petrobras Research Center, Brazil

This paper presents a novel neuro-fuzzy inference system, called RBFuzzy, capable of knowledge extraction and generation of highly interpretable Mamdani-type fuzzy rules. RBFuzzy is a four layer neuro-fuzzy inference system that takes advantage of the functional behavior of Radial Basis Function (RBF) neurons and their relationship with fuzzy inference systems. Inputs are combined in the RBF neurons to compound the antecedents of fuzzy rules. The fuzzy rules consequents are determined by the third layer neurons where each neuron represents a Mamdani-type fuzzy output variable in the form of a linguistic term. The last layer weights each fuzzy rule and generates the crisp output. An extension of the ant-colony optimization (ACO) algorithm is used to adjust the weights of each rule in order to generate an accurate and interpretable fuzzy rule set. For benchmarking purposes some experiments with classic datasets were carried out to compare our proposal with the EFuNN neuro-fuzzy model. The RBFuzzy was also applied in a real world oil well-log database to model and forecast the Rate of Penetration (ROP) of a drill bit for a given offshore well drilling section. The obtained results show that our model can reach the same level of accuracy with fewer rules when compared to the EFuNN, which facilitates understanding the operation of the system by a human expert.

4:40PM *An ANFIS Approach to Transmembrane Protein Prediction [#F-14363]*

Hassan Kazemian and Syed Adnan Yusuf, London Metropolitan University, United Kingdom; Portsmouth University, United Kingdom

This paper is concerned with transmembrane prediction analysis. Most of novel drug design requires the use of Membrane proteins. Transmembrane protein structure allows pharmaceutical industry to design new drugs based on structural layout. However, laboratory experimental structure determination by X-ray crystallography is difficult to be achieved as the hydrophobic molecules do not crystalize easily. Moreover, the sheer number of proteins demands a computational solution to transmembrane regions identifications. This research therefore presents a novel Adaptive Neural Fuzzy Inference System (ANFIS) approach to predict and analyze of membrane helices in amino acid sequences. The ANFIS technique is implemented to predict membrane helices using sliding window data capturing. The paper uses hydrophobicity and propensity to encode the datasets using the conventional one letter symbol of amino acid residues. The computer simulation results show that the offered ANFIS methodology predicts transmembrane regions with high accuracy for randomly selected proteins.

5:00PM *Binary Fish School Search Applied to Feature Selection: Application to ICU Readmissions [#F-14415]*

Joao Sargo, Susana Vieira, Joao Sousa and Carmelo Filho, University of Lisbon, Portugal; University of Pernambuco, Brazil

This paper proposes a novel feature selection approach formulated based on the Fish School Search (FSS) optimization algorithm, intended to cope with premature convergence. In order to use this population based optimization algorithm in feature selection problems, we propose the use of a binary encoding scheme for the internal mechanisms of the fish school search, emerging the binary fish school search (BFSS). The suggested algorithm was combined with fuzzy modeling in a wrapper approach for Feature Selection (FS) and tested over three benchmark databases. This hybrid proposal was applied to an ICU (Intensive Care Unit) readmission problem. The purpose of this application was to predict the readmission of ICU patients within 24 to 72 hours after being discharged. We assessed the experimental results in terms of performance measures and the number of features selected by each used FS algorithms. We observed that our proposal can correctly select the discriminating input features.

5:20PM *The ANFIS Handover Trigger Scheme: The Long Term Evolution (LTE) Perspective [#F-14427]*

Chiew Foong Kwong, Teong Chee Chuah and Su Wei Tan, INTI International University, Malaysia; Multimedia University, Malaysia

With the need for better mobility management strategy to manage increasing demand on efficient data delivery to the user, the Long Term Evolution (LTE) has introduced self-organizing networks (SONs) in order to provide autonomous control over the management of the network. It is important to have a "self- manage" element in the system to provide a "quick-fix" and thus reduce the need of constant human participation in the optimization process of the LTE's mobility management. The existing handover triggering scheme for LTE is not flexible enough to introduce new performance metrics such as user equipment (UE) speed, network jitter or even cell loading. Such requirements for flexibility can only be fulfilled by using flexible tools such as fuzzy logic schemes with adaptive capability to cope with the changes of the fast paced mobile environment. This paper will introduce the use of the adaptive neuro-fuzzy inference system (ANFIS) to provide not only flexibility to LTE for initial deployment, but also the adaptive capability to optimize the efficiency of the handover algorithm with minimal human interference.

5:40PM *Genetic Fuzzy Classifier with Fuzzy Rough Sets for Imprecise Data [#F-14494]*

Janusz Starczewski, Robert Nowicki and Bartosz Nowak, Czestochowa University of Technology, Poland

The main problem addressed in this paper is to handle adequately imprecision of input data by means of a combination of fuzzy methods with the rough set theory. We will make use of fuzzy rough sets derived as rough approximations of fuzzy antecedent sets by non-singleton fuzzy premise sets in a fuzzy classifier. Adaptation of the parameters of this system will be done by the standard genetic algorithm.

6:00PM *An Improvement in Forecasting Interval based Fuzzy Time Series [#F-14499]*

Shanoli Samui Pal, Tandra Pal and Samarjit Kar, NIT Durgapur, India

In this paper, we have proposed a fuzzy interval time series model using a new strategy to replace the conventional defuzzification step, where genetic algorithm has been used to optimize the interval parameters and neural network has been used to learn the trend of the time series. First order fuzzy time series with equal time interval has been used on two data sets, enrollments of the University of Alabama and gold exchange traded fund. We compare the proposed model with two other existing models. The results of the comparisons show that the proposed model performs better.

WeF2-4 Fuzzy Decision Making and Decision Support Systems I

Wednesday, July 9, 4:00PM-6:00PM, Room: 201D, Chair: Mika Sato-Ilic and Mengyin Fu

4:00PM *The Prioritization for Higher Education Institutions Performance Criteria with Fuzzy Analytical Hierarchy Process [#F-14018]*

Rati Wongsathan, Witchakorn Khuankaew and Aitsari Khaothawirat, north-Chiangmai University, Thailand

This research is an investigation of criteria for making a decision of quality in the higher education institutions. The multi-criteria decision was used to achieve the progressive of quality in the university. Fuzzy Analytical Hierarchy Process (FAHP) is applied for these multi-criteria to select the highest prioritizing criteria for achieving the goal of quality institution which can tolerate vagueness and uncertainty of human judgment. The hierarchy consists of 9 main criteria and 44 sub-criteria, recognized by Office of the Higher Education Commission Ministry of Education Thailand, correspond with those main criteria and 6 alternatives from the experts under each sub-criterion. The sensitivity analysis has made by changing the membership function, from triangular membership function to trapezoidal membership function, the studied also changed membership number. However the result of this hypothesis has shown that none of functions variation has impacted the main criteria and alternative. The comparison of preference score and priority of each criterion between FAHP and AHP has the same results.

4:20PM *Use of Cumulative Information Estimations for Risk Assessment of Heart Failure Patients [#F-14029]*

Jan Bohacik, Chandra Kambhampati, Darryl Davis and John Cleland, University of Hull, United Kingdom

As a consequence of aging population and an increasing prevalence of obesity and diabetes there are more and more patients with heart failure. This leads to a lack of professionals who can treat them and to escalating costs. An interesting solution appears to be home telemonitoring with an intelligent clinical decision support system. In this paper, the use of cumulative information estimations for risk assessment of heart failure patients with such a system is analyzed. These cumulative information estimations are utilized for creation of an algorithmic model using fuzzy decision trees that combine decision trees and notions of fuzzy logic. The algorithmic model employs mutual cumulative information and relative mutual cumulative information for association of an important piece of data about the patients with a decision node. The risk assessment with the presented solution is analyzed from the point of view of minimization of life-threatening situations and minimization of costs. Comparisons with a Bayesian network method, a nearest neighbor method, and a logistic regression method show it is a promising solution.

4:40PM *A Quantitative Preference-Based Structured Argumentation System for Decision Support [#F-14122]*

Nouredine Tamani and Madalina Croitoru, INRIA/Graphik - LIRMM, France; Graphik LIRMM IUT-University of Montpellier 2, France

We introduce in this paper a quantitative preference based argumentation system relying on ASPIC argumentation framework and fuzzy set theory. The knowledge base is fuzzified to allow agents expressing their expertise (premises and rules) attached with grades of importance in the unit interval. Arguments are then attached with a strength score aggregating the importance expressed on their premises and rules. Extensions, corresponding to subsets of consistent arguments, are also attached with forces computed based on their strong arguments. The forces are used then to rank extensions from the strongest to the weakest one, upon which decisions can be made. We have also shown that the strength preference relation defined over arguments is reasonable and our fuzzy ASPIC argumentation system can be seen as a computationally efficient instantiation of the generic model of structured argumentation framework.

5:00PM *Fuzzy Group Decision Making Based on Variable Weighted Averaging Operators [#F-14166]*

Deqing Li, Wenyi Zeng and Junhong Li, Beijing Normal University, China

By merging the linguistic quantifier and Borda function, we propose a kind of new method to construct the state variable weight vectors with reward and the variable weight state vector, establish the variable weight synthesis decision making model which grasp the meaning of the linguistic value, and investigate several group decision making models derived by some typical linguistic quantifiers and the OWA operators. Finally, we use one numerical example to illustrate our model reasonable, make the comparison between OWA operator and variable weighted averaging operator, and point out that the quantified guided OWA operator is a pessimistic intendancy decision model, and quantifier guided VWA operator is a optimistic intendancy decision model.

5:20PM *Developing Tw fuzzy DEMATEL Method for Evaluating Green Supply Chain Management Practices [#F-14175]*

Kuo-Ping Lin, Ru-Jen Lin and Kuo-Chen Hung, Lunghwa University of Science and Technology, Taiwan; Hungkuang University, Taiwan

This paper develops a new the weakest t-norm (Tw) fuzzy Decision Making Trial and Evaluation Laboratory (DEMATEL) to evaluate green supply chain management (GSCM). Traditional DEMATEL is a popular method for making decision. In order to apply a realistic environment the fuzzy DEMATEL had to be developed for analyzing expert judgments with preferences, which are often unclear and ambiguous. The fuzzy DEMATEL usually adopts alpha-cut arithmetic operations to calculate results. However, general fuzzy DEMATEL model has not really handled fuzzy cause and effect relationships due to the accumulating phenomenon of fuzziness of the alpha-cut arithmetic. In the numerical example, using novel Tw fuzzy DEMATEL find out real cause and effect relationships with fuzzy bounds among criteria of GSCM. The Tw fuzzy DEMATEL can provide more credible information/results and analysis of across quadrants to evaluate cause and effected relationships, because the decision- maker usually wants to accurately grasp uncertain influential factors in the GSCM.

5:40PM *Gradient-Based Fuzzy Fault Isolation in Residual-Based Fault Detection Systems [#F-14201]*

Francisco Serdio, Edwin Lughofer, Kurt Pichler, Thomas Buchegger, Markus Pichler and Hajrudin Efendic, Johannes Kepler University Linz, Austria; Linz Center of Mechatronics, Austria

We introduce a fault isolation technique based on the analysis of the deformation of data-driven models produced by an incoming fault. Combining the gradients within a model, with the confidence of the model in terms of its quality influenced by the degree of violation of the uncertainty measure used in the fault detection phase allows us to successfully identify faults from the fault alarms produced by a residual-based fault- detection system relying on data-driven models. These models are built from scratch fully automatically on the basis of measurements recorded online and collected off-line in a preliminary batch phase (no physical or expert knowledge required). We used Partial Least Squares (PLS) regression and fuzzy modeling techniques with the inclusion of time lags in the input variables to establish time-varying prediction models. The deformation analysis is performed throughout the warning models (those signaling the presence of a fault), and combines the contributions of all channels to the model prediction and then proposes a candidate faulty channel. We also introduce the concept of a Fault Isolation Likelihood Curve (FILC), inspired by the well-known Receiver Operating Characteristic (ROC) curves, in order to (i) show the isolation rates in a convenient and interpretable way and (ii) allow comparison between the detection and isolation capabilities of a fault detection system. In tandem with the FILC, we introduce the concept of the Fault Isolation Gap (FIG) as a tool for measuring the isolation capabilities of an algorithm with regards to the (fault) detection capabilities achieved by a fault detection method.

Special Session: WeC2-1 CIS and WCCI Competition Session

Wednesday, July 9, 4:00PM-6:00PM, Room: 311A, Chair: Swagatam Das and Alessandro Sperduti

4:00PM *IEEE CIS Ghosts Challenge 2013*

Alessandro Sperduti, University of Padova, Italy

The challenge consists in developing an autonomous agent able to successfully play Geister (a game with partially observable information). Alessandro Sperduti will talk about this competition's progress and results.

4:45PM *Evolutionary Computation for Dynamic Optimization Problems*

Changhe Li, Michalis Mavrovouniotis, Shengxiang Yang and Xin Yao, China University of Geosciences, China; De Montfort University, United Kingdom; University of Birmingham, United Kingdom

This competition aims at evaluating the current state of the art in single objective optimization with bound constraints and to propose novel benchmark problems with diverse characteristics. The algorithms will be evaluated with very small number of function evaluations to large number of function evaluations.

5:10PM *Optimization of Problems with Multiple Interdependent Components*

Sergey Polyakovskiy, Markus Wagner, Mohammad Reza Bonyadi, Frank Neumann and Zbignew Michalewicz, The University of Adelaide, Australia

The competition provides a platform for comparing computational intelligence approaches to solve multi-component optimization problems. The organizers mainly focus on the combination of the TSP and the Knapsack problems in this context. In particular, Euclidian 2D Travelling Salesperson instances are combined with 0-1- Knapsack instances in such a way that it reflects characteristics of the real- world problems; for example, the total weight of the items in the knapsack influences the travel speed of a traveler.

5:35PM *First Neural Connectomics Challenge: From Imaging to Connectivity*

Demian Battaglia, Max Planck Institute for Dynamics and Self-Organization, Germany

This competition aims at advancing the research on network structure reconstruction algorithms from neurophysiological data, including causal discovery methods. The challenge will make use of realistic simulations of real networks of neurons observed via calcium fluorescence recordings. The participants are expected to come up with efficient algorithms for analyzing time series and large data-sets. List of organizers: Isabelle Guyon, Olav Stetter, Demian Battaglia, Javier Orlandi, Jordi Soriano Fradera, Mehreen Saeed, Alexander Statnikov, Bisakha Ray, Alice Guyon, Gavin Cawley, Gideon Dror, Hugo-Jair Escalante, Vincent Lemaire, Sisi Ma, Florin Popescu, and Joshua Vogelstein.

Thursday, July 10, 1:30PM-3:30PM

Special Session: ThF1-1 Hand Skill Recognition and Transfer

Thursday, July 10, 1:30PM-3:30PM, Room: 201A, Chair: Honghai Liu

1:30PM *Active Interaction Control of a Rehabilitation Robot Based on Motion Recognition and Adaptive Impedance Control [#F-14264]*

Wei Meng, Yilin Zhu, Zude Zhou, Kun Chen and Qingsong Ai, Wuhan University of Technology, China

Although electromyography (EMG) signals and interaction force have been widely used in patient cooperative or interactive training, the conventional EMG based control usually breaks the process into a patient-driven phase and a separate passive phase, which is not desirable. In this research, an active interaction controller based on motion recognition and adaptive impedance control is proposed and implemented on a six-DOFs parallel robot for lower limb rehabilitation. The root mean square (RMS) features of EMG signals integrating with the support vector machine (SVM) classifier were used to online predict the lower limb intention in advance and to trigger the robot assistance. The impedance control strategy was adopted to directly influence the robot assistance velocity and allow the exercise to follow a physiological trajectory. Moreover, an adaptive scheme learned the muscle activity level in real time and adapted the robot impedance in accordance with patient's voluntary participation efforts. Experimental results on several healthy subjects demonstrated that the lower limb motion intention can be precisely predicted in advance, and the robot assistance mode was also adjustable based on human-robot interaction and muscle activity level of subjects. Comparing with the conventional EMG-triggered assistance methods, such a strategy can increase patient's motivation because the subject's movement intention, active efforts as well as the muscle activity level changes can be directly reflected in the trajectory pattern and the robot assistance speeds.

1:50PM *Fuzzy Neural Network-Based Adaptive Impedance Force Control Design of Robot Manipulator under Unknown Environment [#F-14215]*

Wei-Chen Wang and Ching-Hung Lee, National Chung Hsing University, Taiwan

In this paper, an adaptive impedance force control scheme for an n-link robot manipulator under unknown environment is proposed. The system dynamics of the robot manipulator is assumed that system model is not exactly known or has system uncertainty. Therefore, the traditional adaptive impedance force controller is not valid. Herein, the fuzzy neural networks are adopted to estimate the system model terms of robot and the force tracking control is developed by the proposed adaptive scheme. The proposed scheme is established by gradient descent approach. Using the Lyapunov stability theory, the update laws of fuzzy neural networks can be derived and the stability of the closed-loop system is guaranteed. Finally, simulation results of a two-link robot manipulator with environment constraint are introduced to illustrate the performance and effectiveness of our approach.

2:10PM *Finger Pinch Force Estimation through Muscle Activations Using a Surface EMG Sleeve on the Forearm [#F-14392]*

Yinfeng Fang, Zhaojie Ju, Xiangyang Zhu and Honghai Liu, University of Portsmouth, United Kingdom; Shanghai Jiao Tong University, China

For prosthetic hand manipulation, the surface Electromyography(sEMG) has been widely applied. Researchers usually focus on the recognition of hand grasps or gestures, but ignore the hand force, which is equally important for robotic hand control. Therefore, this paper concentrates on the methods of finger forces estimation based on multi-channel sEMG signal. A custom-made sEMG sleeve system omitting the stage of muscle positioning is utilised to capture the sEMG signal on the forearm. A mathematic model for muscle activation extraction is established to describe the relationship between finger pinch forces and sEMG signal, where the genetic algorithm is employed to optimise the coefficients. The results of experiments in this paper shows three main contributions: 1) There is a systematical relationship between muscle activations and the pinch finger forces. 2) To estimate the finger force, muscle precise positioning for electrodes placement is not inevitable. 3) In a multi-channel EMG system, selecting specific combinations of several channels can improve the estimation accuracy for specific gestures.

2:30PM *Joint Angle Estimation System for Rehabilitation Evaluation Support [#F-14497]*

Junya Kusaka, Takenori Obo, Janos Botzheim and Naoyuki Kubota, Tokyo Metropolitan University, Japan

In this research, we propose a methodology for getting joint angles by Kinect sensor for rehabilitation evaluation support. We measure the motion of the arm of a patient with hemiplegia before and after the rehabilitation, and estimate the range of the motion by using genetic algorithm and neural network. The range after the rehabilitation is bigger than before the rehabilitation. Based on this result, our methodology is able to evaluate the change of the motion before and after the rehabilitation for patients with hemiplegia.

2:50PM *Fuzzy-Based Adaptive Motion Control of a Virtual iCub Robot in Human-Robot-Interaction [#F-14539]*

Zejun Xu, Chenguang Yang, Hongbin Ma and Mengyin Fu, Beijing Institute of Technology, China; Plymouth University, United Kingdom

In this paper, in order to combine intelligence of human operator and automatic function of the robot, we design a control scheme for the bimanual robot manipulation, in which the leading robot arm is directly manipulated by a human operator through a haptic device and the following robot arm will automatically adjust its motion to match the operator's motion. In this paper, we propose a fuzzy based adaptive feed forward compensation controller and apply it into the robot control. According to the comparison results in the simulated experiment, we conclude that the fuzzy-adaptive controller performs better than the non-fuzzy controller, although they can both complete the specified task by tracking the leading robot arm controlled by the human operator. The techniques developed in this paper could be very useful for our future study on adaptation in human-robot interaction in improving the reliability, safety and intelligence.

3:10PM *Teleoperation of a Virtual iCub Robot under Framework of Parallel System via Hand Gesture Recognition [#F-14541]*

Chen Li, Hongbin Ma, Chenguang Yang and Mengyin Fu, Beijing Institute of Technology, China; Plymouth University, United Kingdom

This paper describes our preliminary development of a virtual robot teleoperation platform based on hand gesture recognition using visual information. Hand gestures in images captured by a camera are recognised to control a virtual iCub. We employ two methods to realise the classification: Adaptive Neuro-fuzzy Inference Systems (ANFIS) and Support Vector Machines (SVM). We realise the teleoperation of a virtual robot using iCubSimulator. The technique in the paper will enable us to teleoperate a physical robot in the future work. In addition, a video server is set up to monitor the real robot. By using the parallel system we are able to improve the robot's performance. Based on the techniques presented in this paper, the virtual iCub can perform the specified actions remotely in a natural manner.

Special Session: ThF1-2 Hybridisations, Extensions, and High-Order Fuzzy Sets

Thursday, July 10, 1:30PM-3:30PM, Room: 201B, Chair: Neil Mac Parthaláin and Richard Jensen

1:30PM *Approximate Nature of Traditional Fuzzy Methodology Naturally Leads to Complex-Valued Fuzzy Degrees [#F-14045]*

Olga Kosheleva and Vladik Kreinovich, University of Texas at El Paso, United States

In the traditional fuzzy logic, the experts' degrees of confidence in their statements is described by numbers from the interval [0,1]. These degree have a clear intuitive meaning. Somewhat surprisingly, in some applications, it turns out to be useful to also consider different numerical degrees -- e.g., complex-valued degrees. While these complex-valued degrees are helpful in solving practical problems, their intuitive meaning is not clear. In this paper, we provide a possible explanation for the success of complex-valued degrees which makes their use more intuitively understandable -- namely, we show that these degrees naturally appear due to the approximate nature of the traditional fuzzy methodology.

1:50PM *Tightly Coupled Fuzzy Rough Description Logic Programs under the Answer Set Semantics for the Semantic Web [#F-14056]*

Tingting Zou, Yanpeng Qu and Ansheng Deng, Dalian Maritime University, China

The Semantic Web is an extension of the current World Wide Web, and aims to help computers to understand and process web information automatically. In recent years, the integration ontologies and rules has become a central topic in the Semantic Web. Therefore, significant research efforts have focused on integration description logic programs. However, description logic programs cannot well model a great deal of real-world problems because of the restriction of represented formalism. To address this problem, we further extend description logic programs such that they can deal with imprecise information, uncertain information and non monotonic reasoning at the same time. In this paper, we propose tightly coupled fuzzy rough description logic programs (or simply fuzzy rough dl-program) under the answer set semantics, which are tightly integrates fuzzy rough disjunctive programs under the answer set semantics with fuzzy rough description logics. To our knowledge, this is the first such approach. First of all, we define the syntax and semantics of fuzzy rough disjunctive logic programs, which is the rough extension of fuzzy disjunctive logic programs based on rough set theory. Then, we define the syntax and semantics of fuzzy rough dl-program. Finally, we show some

semantic properties of fuzzy rough dl-program under the answer set semantics.

2:10PM *Feature Grouping-Based Fuzzy-Rough Feature Selection [#F-14247]*

Richard Jensen, Neil Mac Parthalain and Chris Cornelis, Aberystwyth University, United Kingdom; University of Granada, Spain

Data dimensionality has become a pervasive problem in many areas that require the learning of interpretable models. This has become particularly pronounced in recent years with the seemingly relentless growth in the size of datasets. Indeed, as the number of dimensions increases, the number of data instances required in order to generate accurate models increases exponentially. Feature selection has therefore become not only a useful step in the process of model learning, but rather an increasingly necessary one. Rough set and fuzzy-rough set theory have been used as such dataset pre-processors with much success, however the underlying time/space complexity of the subset evaluation metric is an obstacle to the processing of very large data. This paper proposes a general approach to this problem that employs a novel feature grouping step in order to alleviate the processing overhead for large datasets. The approach is framed within the context of (and applied to) fuzzy-rough sets, although it can be used with other subset evaluation techniques. The experimental evaluation demonstrates that considerable computational effort can be avoided, and as a result efficiency can be improved considerably for larger datasets.

2:30PM *An Advancing Investigation on Reduct and Consistency for Decision Tables in Variable Precision Rough Set Models [#F-14359]*

James N. K. Liu, Yanxing Hu, Jia You and He Yulin, The Hong Kong Polytechic University, Hong Kong; Hebei University, China

Variable Precision Rough Set (VPRS) model is one of the most important extensions of the Classical Rough Set (RS) theory. It employs a majority inclusion relation mechanism in order to make the Classical RS model become more fault tolerance, and therefore the generalization of the model is improved. This paper can be viewed as an extension of previous investigations on attribution reduction problem in VPRS model. In our investigation, we illustrated with examples that the previously proposed reduct definitions may spoil the hidden classification ability of a knowledge system by ignoring some essential attributes in some certain circumstances. Con- sequently, by proposing a new beta-consistent notion, we analyze the relationship between the structures of Decision Table (DT) and different definitions of reduct in VPRS model. Then we give a new notion of beta-complement reduct that can avoid the defects of reduct notions defined in previous literatures, and also supply the method to obtain the beta-complement reduct by a decision table splitting algorithm, and finally we verify the feasibility of our approach with instances.

2:50PM *Heuristic Search for Fuzzy-Rough Bireducts and Its Use in Classifier Ensembles [#F-14444]*

Ren Diao, Neil Mac Parthalain, Richard Jensen and Qiang Shen, Aberystwyth University, United Kingdom

Rough set theory has proven to be a useful mathematical basis for developing automated computational approaches which are able to deal with and utilise imperfect knowledge. Fuzzy- rough set theory is an extension to rough set theory and enhances the ability to model uncertainty and vagueness more effectively. There have been many developments in this area which offer robust methods for feature selection or instance selection. However, these are often carried out in isolation rather than considering both types of selection simultaneously. For this purpose, the notion of a bireduct has been proposed recently but the task of finding bireducts of high quality remains a significant challenge. This paper presents a heuristic strategy for the identification of fuzzy-rough bireducts, which is based on a music-inspired global optimisation algorithm called harmony search. The concept of e- bireducts is employed in this approach for the evaluation and improvisation of the candidate solutions. The stochastically-selected bireducts are also utilised to construct classifier ensembles. The presented technique is experimentally evaluated using a number of real-valued benchmark data sets.

3:10PM *Hybrid Fuzzy Genetics-Based Machine Learning with Entropy-Based Inhomogeneous Interval Discretization [#F-14546]*

Yuji Takahashi, Yusuke Nojima and Hisao Ishibuchi, Osaka Prefecture University, Japan

Discretization of continuous attributes is a key issue in classifier design from numerical data. In the machine learning community, continuous attributes are discretized into intervals. An entropy measure is often used to determine the cutting points for interval discretization. In the fuzzy system community, continuous attributes are usually discretized into overlapping fuzzy sets. Learning and optimization techniques are used to adjust the membership function of each fuzzy set. One interesting research issue is a comparison between interval partitions and fuzzy partitions. We address this issue by using an entropy-based interval discretization method in hybrid fuzzy genetics- based machine learning (GBML). Our hybrid fuzzy GBML algorithm is applied to a number of data sets where interval discretization is fuzzified with different fuzzification grades from zero (i.e., interval partitions) to one (i.e., completely fuzzified partitions). Experimental results from various fuzzification grades are compared with each other.

ThF1-3 Fuzzy Clustering

Thursday, July 10, 1:30PM-3:30PM, Room: 201C, Chair: Seiichi Ozawa and Xiao-Jun Zeng

1:30PM *Incremental Fuzzy Clustering for Document Categorization [#F-14051]*

Jianping Mei, Yangtao Wang, Lihui Chen and Chunyan Miao, Zhejiang University of Technology, China; Nanyang Technological University, Singapore

Incremental clustering has been proposed to handle large datasets which can not fit into memory entirely. Single pass fuzzy c-means (SpFCM) and Online fuzzy c- means (OFCM) are two representative incremental fuzzy clustering methods. Both of them extend the scalability of fuzzy c-means (FCM) by processing the dataset chunk by chunk. However, due to the data sparsity and high-dimensionality, SpFCM and OFCM fail to produce reasonable results for document data. In this study, we work on clustering approaches that take care of both the large-scale and high-dimensionality issues. Specifically, we propose two methods for incrementally clustering of document data. The first method is a modification of the existing FCM-based incremental clustering with a step to normalize the centroids in each iteration, while the other method is incremental clustering, i.e., Single-Pass or Online, with weighted fuzzy co-clustering. We use several benchmark document datasets for experimental study. The experimental results show that the proposed approaches achieved significant improvements over existing SpFCM and OFCM in document clustering.

1:50PM *Enhanced Cluster Validity Index for the Evaluation of Optimal Number of Clusters for Fuzzy C-Means Algorithm [#F-14109]*

Neha Bharill and Aruna Tiwari, Indian Institute of Technology, Indore, India

Cluster validity index is a measure to determine the optimal number of clusters denoted by (C) and an optimal fuzzy partition for clustering algorithms. In this paper, we proposed a new cluster validity index to determine an optimal number of hyper-ellipsoid or hyper-spherical shape clusters generated by Fuzzy C-Means (FCM) algorithm called as V IDSO index. The proposed validity index jointly exploits all the three measures named as intra-cluster compactness, an inter-cluster separation and overlap between the clusters. The proposed intra-cluster compactness is based on relative variability concept which is a statistical measure of relative dispersion or scattering of data in various dimensions within the clusters. The proposed inter-cluster separation measure indicates the isolation or distance between the fuzzy clusters. The proposed inter-cluster overlap measure determines the degree of overlap between the fuzzy clusters. The best fuzzy partition produced by the VIDSO index is expected to have low degree of intra-cluster compactness, higher degree of inter-cluster separation and low degree of inter-cluster overlap. The efficacy of VIDSO index is evaluated on six benchmark data sets and compared with a number of known validity indices. The experimental results and the comparative study demonstrate that, the proposed index is highly effective and reliable in estimating the optimal value of C and an optimal fuzzy partition for each data set because, it is insensitive with change in values of fuzzification parameter denoted by m. In contrast, the other indices [2], [3], [6], [7] fails to achieve the optimal value of C due to it is susceptibility with change in m.

2:10PM *A Learning Scheme to Fuzzy C-Means Based on a Compromise in Updating Membership Degrees [#F-14367]*

Shang-Lin Wu, Yang-Yin Lin, Yu-Ting Liu, Chih-Yu Chen and Chin-Teng Lin, National Chiao Tung University, Taiwan

Fuzzy C-Means (FCM) clustering is the most well-known clustering method according to fuzzy partition for pattern classification. However, there are some disadvantages of using that clustering method, such as computational complexity and execution time. Therefore, to solve these drawbacks of FCM, the two-phase FCM procedure has been proposed in this study. Compared with the conventional FCM, the usage of a compromised learning scheme makes more adaptive and effective. By performing the proposed approach, the unknown data could be rapidly clustered according to the previous information. A synthetic data set with two dimensional variables is generated to estimate the performance of the proposed method, and to further demonstrate that our method not only reduces computational complexity but economizes execution time compared with the conventional FCM in each example.

2:30PM *Link-Based Pairwise Similarity Matrix Approach for Fuzzy C-Means Clustering Ensemble [#F-14421]*

Pan Su, Changjing Shang and Qiang Shen, Aberystwyth University, United Kingdom

Cluster ensemble offers an effective approach for aggregating multiple clustering results in order to improve the overall clustering robustness and stability. It also helps improve accuracy by combing clustering results from component methods that utilise different parameters (e.g., number of clusters), avoiding the need for carefully pre-setting the values of such parameters in a single clustering process. Since founded, many topics regarding cluster ensemble have been proposed and promising results gained. These include the generation of ensemble members and consensus of ensemble members. In this paper, link-based consensus methods for the ensemble of fuzzy c-means are proposed. Different from traditional clustering techniques, the clusters which are generated by fuzzy c-means are fuzzy sets. The proposed methods therefore employ a fuzzy graph to represent the relationships between component clusters upon which to derive the final ensemble clustering results. Using various benchmark datasets, the proposed methods are tested against typical traditional methods. The experimental results demonstrate that the proposed fuzzy-link-based clustering ensemble approach generally outperforms the others in terms of accuracy.

2:50PM *Fuzzy Clustering Using Automatic Particle Swarm Optimization [#F-14518]*

Min Chen and Ludwig Simone, North Dakota State University, United States

Fuzzy clustering is a popular unsupervised learning method used in cluster analysis which allows a data point to belong to two or more clusters. Fuzzy c-means is one of the most well-known and used methods, however, the number of clusters need to be defined in advance. This paper proposes a clustering approach based on Particle Swarm Optimization. This approach automatically determines the optimal number of clusters using a threshold vector that is added to the particle. The algorithm starts by partitioning the data set randomly within a preset maximum number of clusters in order to overcome the fuzzy c-means shortcoming of the predefined cluster count. A reconstruction criterion is applied to evaluate the performance of the clustering results of the proposed algorithm. The experiments conducted show that the proposed algorithm can automatically find the optimal number of clusters.

3:10PM *A Preprocessed Induced Partition Matrix Based Collaborative Fuzzy Clustering for Data Analysis [#F-14525]*

Mukesh Prasad, Dong Lin Li, Yu-Ting Liu, Linda Siana, Chin-Teng Lin and Amit Saxena, National Chiao Tung University, Taiwan; Guru Ghasidas Vishwavidyalaya, India

Preprocessing is generally used for data analysis in the real world datasets that are noisy, incomplete and inconsistent. In this paper, preprocessing is used to refine the inconsistency of the prototype and partition matrices before getting involved in the collaboration process. To date, almost all organizations are trying to establish some collaboration with others in order to enhance the performance of their services. Due to privacy and security issues they cannot share their information and data with each other. Collaborative clustering helps this kind of collaborative process while maintaining the privacy and security of data and can still yield a satisfactory result. Preprocessing helps the collaborative process by using an induced partition matrix generated based on cluster prototypes. The induced partition matrix is calculated from local data by using the cluster prototypes obtained from other data sites. Each member of the collaborating team collects the data and generates information locally by using the fuzzy c-means (FCM) and shares the cluster prototypes to other members. The other members preprocess the centroids before collaboration and use this information to share globally through collaborative fuzzy clustering (CFC) with other data. This process helps system to learn and gather information from other data sets. It is found that preprocessing helps system to provide reliable and satisfactory result, which can be easily visualized through our simulation results in this paper

3:30PM *Dynamic Texture Classification Using Local Fuzzy Coding [#F-14245]*

Liuyang Wang, Huaping Liu and Fuchun Sun, Tsinghua University, China

Recognition of complex dynamic texture is a challenging problem and captures the attention of the computer vision community for several decades. Essentially the dynamic texture recognition is a multi-class classification problem that has become a real challenge for computer vision and machine learning techniques. In this paper, we propose a new approach to tackle the dynamic texture recognition problem. First, we utilize the fuzzy clustering technology to design a fuzzy codebook, and then construct a soft assigned local fuzzy coding feature to represent the whole dynamic texture sequence. This new coding strategy preserves spatial and temporal characteristics of dynamic texture. Finally, by evaluating the proposed approach using with the DynTex dataset, we show the effectiveness of the proposed local fuzzy coding strategy.

ThF1-4 Fuzzy Systems Modelling and Identification

Thursday, July 10, 1:30PM-3:30PM, Room: 201D, Chair: Faa-Jeng Lin and Jozo Dujmovic

1:30PM *A New Monotonicity Index for Fuzzy Rule-Based Systems [#F-14053]*

Lie Meng Pang, Kai Meng Tay and Chee Peng Lim, Universiti Malaysia Sarawak, Malaysia; Deakin University, Australia

A search in the literature reveals that mathematical conditions (usually sufficient conditions) for the Fuzzy Inference System (FIS) models to satisfy the monotonicity property have been developed. A monotonically-ordered fuzzy rule base is important to maintain the monotonicity property of an FIS. However, it may difficult to obtain a monotonically-ordered fuzzy rule base in practice. We have previously introduced the idea of fuzzy rule relabeling to tackle this problem. In this paper, we further propose a monotonicity index for the FIS system, which serves as a metric to indicate the degree of a fuzzy rule base fulfilling the monotonicity property. The index is useful to provide an indication whether a fuzzy rule base should (or should not) be used in practice, even with fuzzy rule relabeling. To illustrate the idea, the zero-order Sugeno FIS model is exemplified. We add noise as errors into the fuzzy rule base to formulate a set of non-monotone fuzzy rules. As such, the metric also acts as a measure of noise in the fuzzy rule base. The results show that the proposed metric is useful to indicate the degree of a fuzzy rule base fulfilling the monotonicity property.

1:50PM *Sparse Fuzzy C-Regression Models with Application to T-S Fuzzy Systems Identification [#F-14069]*

Minnan Luo, Fuchun Sun and Huaping Liu, Tsinghua University, China

In this paper, the objective function of fuzzy c-regression models (FCRM) is modified to develop a novel fuzzy partition method on the basis of block structured sparse representation, namely as sparse fuzzy c-regression model. This method takes advantage of the block structured information in the objective function of FCRM and casts fuzzy partition into an optimization problem by making a tradeoff between traditional FCRM and the number of prototypes of hyper-plane with nonzero parameters. An alternating direction method of multipliers (ADMM) based algorithm is exploited to address the proposed optimization problem. Furthermore, based on sparse fuzzy c-regression models, a novel T-S fuzzy systems identification method is developed for reduction of fuzzy rules. Finally, examples on well-known benchmark data set are carried out to illustrate the effectiveness of the proposed methods.

2:10PM *A Systems Approach for Scheduling Aircraft Landings in JFK Airport [#F-14104]*

Sina Khanmohammadi, Chun-An Chou, Harold W. Lewis III and Doug Elias, SUNY Binghamton, United States

The aircraft landings scheduling problem at an airport has become very challenging due to the increase of air traffic. Traditionally, this problem has been widely studied by formulating it as an optimization model solved by various operation research approaches. However, these approaches are not able to capture the dynamic nature of the aircraft landing scheduling problem appropriately and handle uncertainty easily. A systems approach provides an alternative to solve such a problem from a systematic perspective. In this regard, the concept of general systems problem solving (GSPS) was first introduced in 1970s, and yet the power of the GSPS methodology is not fully discovered as it had only been applied to few domains. In this paper, a new general systems problem solving framework integrating computational intelligence techniques (GSPS-CI) is introduced. The two main functions of the framework are: (1) adaptive network based fuzzy inference system (ANFIS) to predict flight delays, and (2) fuzzy decision making procedure to schedule aircraft landings. The effectiveness of the GSPS-CI framework is tested on the JFK airport in USA, one of the most complex real-life systems.

2:30PM *A New Fuzzy Ratio and Its Application to the Single Input Rule Modules Connected Fuzzy Inference System [#F-14137]*

Chian Haur Jong, Kai Meng Tay and Chee Peng Lim, Universiti Malaysia Sarawak, Malaysia; Deakin University, Australia

The principle of ratios has been applied to many real world problems, e.g. the part-to-part and part-to-whole ratio formulations. As it is difficult for humans to provide an exact ratio in many real situations, we introduce a fuzzy ratio in this paper. We use some notions from fuzzy arithmetic to analyze fuzzy ratios captured from humans. An application of the formulated fuzzy ratio to a Single Input Rule Modules connected Fuzzy Inference System (SIRMs-FIS) is demonstrated. Instead of using a precise weight, fuzzy sets are employed to represent the relative importance of each rule module. The resulting fuzzy weights are explained as a fuzzy ratio on a weight domain. In addition, a new SIRMs-FIS model with fuzzy weights and part-to-whole fuzzy ratio is devised. A simulated example is presented to clarify the proposed SIRM-FIS model.

2:50PM *Fuzzy Uncertainty Assessment in RBF Neural Networks Using Neutrosophic Sets for Multiclass Classification [#F-14282]*

Adrian Rubio-Solis and George Panoutsos, University of Sheffield, United Kingdom

This paper describes a fuzzy uncertainty assessment methodology by using an RBF neural network (RBF-NN) and neutrosophic sets (NS) for multiclass classification. Since the RBF-NN can be viewed as a type of Fuzzy Logic System (FLS), the information related to two types of uncertainty, namely; a) fuzziness and b) ambiguity contained in each receptive unit (RU) in the RBF-NN can be exploited and explored via the use of NS and then make more transparent and distinguishable the training of the RBF-NN. On the one hand, we define the neutrosophic tuple <T, F, I_k> based on the firing strength in order to evaluate the fuzziness produced by the overlapping area among the RU's. On the other hand, a second tuple <T, F, I_{ji}^k> based on the normalised RU output is used to evaluate the individual ambiguity in the RU's and then the average ambiguity is computed in order to construct a modelling framework based on neutrosophic sets. Finally, the proposed methodology is tried out for modelling the well-know IRIS data set and for non-linear system identification and mechanical property prediction of the Charpy Toughness of heat-treated steel.

3:10PM *A New Adaptive Mamdani-Type Fuzzy Modeling Strategy for Industrial Gas Turbines [#F-14439]*

Yu Zhang, Jun Chen, Chris Bingham and Mahdi Mahfouf, University of Lincoln, United Kingdom; University of Sheffield, United Kingdom

The paper presents a new system identification methodology for industrial systems. Using the original Mamdani fuzzy rule based system (FRBS), an adaptive Mamdani fuzzy modeling (AMFM) is introduced in this paper. It differs from the original Mamdani FRBS in that it applies different membership functions and a defuzzification mechanism that is 'differentiable' with respect to the membership function parameters. The proposed system also includes a back error propagation (BEP) algorithm that is used to refine the fuzzy model. The efficacy of the proposed AMFM approach is demonstrated through the experimental trails from a compressor in an industrial gas turbine system.

3:30PM *Introduction to Tunable Equivalence Fuzzy Associative Memories [#F-14485]*
Estevao Esmi, Peter Sussner and Sandra Sandri, Unicamp, Brazil; INPE, Brazil
In this paper, we present a new class of fuzzy associative memories (FAMs) called {\em tunable equivalence fuzzy associative memories}, for short tunable E-FAMs or TE-FAMs, that belong to the class \Theta-fuzzy associative memories (\Theta-FAMs). Recall that \Theta-FAMs represent fuzzy neural networks having a competitive hidden layer and weights that can be adjusted via a training algorithm. Like any associative memory model, \Theta-FAMs depend on the specification of a fundamental memory set. In contrast to other \Theta-FAM models, TE-FAMs make use of parametrized fuzzy equivalence measures that are associated with the hidden nodes and allow for the extraction of a fundamental memory set from the training data. The use of a smaller fundamental memory set than in previous articles on \Theta-FAMs reduces the computational effort involved in deriving the weights without decreasing the quality of the results.

Thursday, July 10, 3:30PM-6:00PM

Poster Session: PF4 Fuzzy Modeling, Control, & Applications II

Thursday, July 10, 3:30PM-6:00PM, Room: Posters Area (Level 2), Chair: Tomoharu Nakashima and Neha Bharill

P701 *Reengineering Fuzzy Nested Relational Databases into Fuzzy XML Model [#F-14071]*
Weijun Li, Xu Chen and Z. M. Ma, Northeastern University, China
Data interchange on the Web is a common task today and XML has been the de-facto standard of information representation and exchange over the Web. Also information imperfection is inherent in the real-world applications. Fuzzy information has been extensively investigated in the context of database models. Also fuzzy XML modeling recently receives more attention. In order to present fuzzy data from the fuzzy databases with XML, this paper concentrates on fuzzy information modeling in the fuzzy XML model and the fuzzy nested relational database model. The formal approach to mapping a fuzzy nested relational database (FNRDB) schema into a fuzzy DTD model is developed in the paper.

P702 *Evaluation of Responsiveness of Health Systems Using Fuzzy-based Technique [#F-14084]*
Sukanya Phongsuphap and Yongyuth Pongsupap, Mahidol University, Thailand; National Health Security Office, Thailand
This paper proposes a method for evaluating responsiveness of health systems. The method is based on a fuzzy model, which can tackle uncertainty of survey data, and perform corresponding to the way that human being makes decisions and adjustments. To measure responsiveness of health systems, we have defined five fuzzy sets for two input variables: score of direct experience of using health service and score of anchoring vignette, and five fuzzy sets for one output variable: responsiveness score which is defined as the difference between score of direct experience of using health service and score of vignette. The twenty- five fuzzy rules are derived from the analysis of input and output variables association. Mamdani style inference technique is used to compute a crisp value of average responsiveness score for each component of health systems, and the overall average responsiveness score is computed by using the weight average method. The data of seven components based on WHO framework were collected from 4,446 outpatients of three schemes of health care systems in Thailand consisting of Civil Servant Medical Benefit Scheme (CSMBS), Social Security Scheme (SSS), and Universal Coverage Scheme (UCS). Results showed that CSMBS got the highest average responsiveness score followed by SSS which got a slightly higher average responsiveness score than UCS, but there are some variations in each of seven components. The proposed method of responsiveness evaluation can provide concise information both in terms of quantitative and qualitative measures, which can be used as a policy implication to assist government and health system policy makers in improving and providing the more suitable heath care services.

P703 *A Fuzzy Logic Based Parkinson's Disease Risk Predictor [#F-14136]*
Siyuan Liu, Zhiqi Shen, Martin J. McKeown, Cyril Leung and Chunyan Miao, Nanyang Technological University, Singapore; The University of British Columbia, Canada
With the world population aging rapidly, improving the quality of life for senior citizens has become an important societal issue. Parkinson's Disease (PD) is one of the most debilitating neuro-degenerative disorders that seriously affect the seniors' quality of life. In recent years, video games have been shown to be a viable way through which partial rehabilitation for PD can be carried out in a fun and low cost manner. Earlier research has shown that both patients' physical and mental conditions can be improved by playing video games. However, so far, the available games developed for PD are mostly intended for rehabilitation purposes. PD diagnosis still depends on the traditional neurological exams and experience of doctors, which require the patients to become self-aware of the symptoms and are usually too late for the patients to delay the progression of PD. To support the early detection of PD symptoms, we propose a fuzzy logic based PD risk predictor that has been implemented in a tablet game platform. The player's behavior data in the game environment are captured unobtrusively and analyzed in real-time. The player's current risk of developing PD is estimated using the proposed fuzzy logic based approach, which will help the player to be aware of high risk of having PD at an earlier stage. A pilot evaluation has been conducted to demonstrate the effectiveness of the proposed approach.

P704 *An Integrated Intelligent Technique for Monthly Rainfall Time Series Prediction [#F-14142]*
Jesada Kajornrit, Kok Wai Wong, Chun Che Fung and Yew Soon Ong, Murdoch University, Australia; Nanyang Technological University, Singapore
This paper proposes a methodology to create an interpretable fuzzy model for monthly rainfall time series prediction. The proposed methodology incorporates the advantages of artificial neural network, fuzzy logic and genetic algorithm. In the first step, the differences between the time series data are calculated and they are used to define the interval between the membership functions of a Mamdani-type fuzzy inference system. Next, artificial neural network is used to develop the model from input-output data and the established model is then used to extract the fuzzy rules. The parameters of the created fuzzy model are then optimized by using genetic algorithm. The proposed model was applied to eight monthly rainfall time series data in the northeast region of Thailand. The experimental results showed that the proposed model pro-vided satisfactory prediction accuracy when compared to other commonly-used prediction models. Due to the interpretability nature of the model, human analysts can gain insight know-ledge of the data to be modeled.

P705 *A Fuzzy Ontology Driven Method for a Personalized Query Reformulation [#F-14446]*

Hajer Baazaoui-zghal and Henda Ben ghezala, Riadi-gdl laboratory, Tunisia

Ontologies have proven their utility in the area of Information Retrieval. However, building and updating ontologies manually is a long and tedious task. Moreover, crisp ontologies are not capable to support uncertain information. One interesting solution is to integrate fuzzy logic into ontology to handle vague and imprecise information. This paper presents a method for individual fuzzy ontology building. The key aspects in our proposal are: (1) an automatic building of an individual fuzzy ontology; (2) a query reformulation based, on the one hand, on the weights associated with the concepts and all existing relations in the fuzzy ontology and, on the other hand, on users' preferences, (3) an update of the membership concepts and relations' values after each users search, and (4) the use of the proposed fuzzy ontology and service ontology to individually classify documents by services. Our method has endured a twofold evaluation. Firstly, we have evaluated the impact of the update and the weights' variations on the search results. Secondly, we have studied how the query reformulation has led to a quality results improvement, both in terms of precision and recall.

P706 *A Comparison of Computational Intelligence Techniques for Energy Time Series Forecasting [#F-14465]*

Abbas Namdar and Hamid Berenji, University of Mazandaran, Iran; Intelligence Inference Systems Corp, United States

Energy time series forecasting plays a crucial role in the process of energy planning. This topic has been, and is still attracting vast research activities that are performed by researchers in the academia and energy companies. Various techniques exist for energy time series forecasting, and the selection of the most suitable forecasting algorithm is not an easy process. For a clear application of such techniques in energy time series forecasting, there should be a clear distinction between these techniques. This paper compares the overall performance of the Time Delay Neural network (TDNN), Neuro Fuzzy Inference System and Support Vector Regression (SVR). The efficiency of these techniques is compared in energy time series forecasting, and the performance of them is tested. The results of our analysis indicate that the Time Delay Neural network (TDNN) show the best performances overall.

P707 *Perceptual Computing Based Performance Control Mechanism for Power Efficiency in Mobile Embedded Systems [#F-14506]*

Prashant Gupta and Pranab Muhuri, South Asian University, India

A computing with words/Per-C based user feedback collection model for controlling the processor power efficiency is introduced. Needless to say that CWW/Per-C is a very efficient tool in modelling human perceptions. Here the objects of computation are the words drawn from natural language instead of numbers. Perceptions alone don't make the sole criteria rather the backed logic of reasoning is also a supportive tool in the same scenario. In our pre-sent work, we have proposed a new algorithm viz. UFOPeC (user feedback optimized perceptual computing) for obtain-ing the optimal power efficiency in adaptive computing sys- tems that can run at multiple operating voltages. Our approach models the user satisfaction very well and more real-istically as compared to than the other existing mechanisms like HAPPE as we have taken the user feedback in terms of words and modelled the same using the IT2 FSs (interval type-2 fuzzy sets). An appropriate numerical example has been chosen to demonstrate the design of our model.

P708 *Medical Diagnosis and Monotonicity Clarification Using SIRMs Connected Fuzzy Inference Model with Functional Weights [#F-14508]*

Hirosato Seki and Tomoharu Nakashima, Kwansei Gakuin University, Japan; Osaka Prefecture University, Japan

This paper discusses the SIRMs (Single-Input Rule Modules) connected fuzzy inference model with functional weights (SIRMs model with FW). The SIRMs model with FW consists of a number of groups of simple fuzzy if-thenrules with only a single attribute in the antecedent part. The final outputs ofconventional SIRMs model are obtained by summarizing product of the functional weight and inference result from a rule module. In the SIRMs model of the paper, we firstly clarify its monotonicity. Secondly, we apply the SIRMs model with FW to medical diagnosis.

P709 *T-S Fuzzy Models Based Approximation for General Fractional Order Nonlinear Dynamic Systems [#F-14003]*

Yong Wang, Yiheng Wei, Min Zhu, Mengmeng Liu, Cheng Peng and Zeshao Chen, University of Science and Technology of China, China; North China Institute of Science and Technology, China; Northeastern University, China

In this paper, a novel approach is presented to approximate the general fractional order nonlinear dynamic systems. Firstly, a generalized T-S fuzzy method is used to approximate the original models. Then a new method to approximate the fractional order T-S models is utilized, and obtain a series of integer order linear model. It is revealed for the first time that a general fractional order nonlinear system (FONS) can be approximated by a series of integer order linear models to any degree of accuracy on any compact set. Finally, numerical simulation results are provided to illustrate the effectiveness of the proposed approach.

P710 *A Mathematical Programming Method for the Multiple Attribute Decision Making with Interval Intuitionistic Fuzzy Values [#F-14265]*

Junfeng Chu and Xinwang Liu, Southeast University, China

In this paper, we investigate the multiple attribute decision making problems where the decision-making information and attribute weight vector are both given by the interval-valued intuitionistic fuzzy number (IVIFN). We introduce a mathematical model to obtain the comprehensive value of each alternative by the form of IVIFN. Then we utilize the TOPSIS method to rank all the alternatives. Finally, an illustrative example is used to illustrate applicability of the proposed method.

P711 *Fuzzy Multi Entity Bayesian Networks: A Model for Imprecise Knowledge Representation and Reasoning in High-Level Information Fusion [#F-14477]*

Keyvan Golestan, Fakhri Karray and Mohamed S. Kamel, University of Waterloo, Canada

This paper presents a novel comprehensive Fuzzy extension to Multi-Entity Bayesian Networks (MEBN) that is deemed a well-studied and theoretically rich language that expressively handles semantics analysis, and effectively model uncertainty management. However, MEBN lack the capability of modeling the inherent conceptual and structural ambiguity that is delivered with the knowledge gained through human language. In this paper, Fuzzy MEBN that is a new version of MEBN which is based on First-order Fuzzy Logic, and Fuzzy Bayesian Networks is introduced. Furthermore, its applicability is evaluated by implementing an application related to Vehicular Ad-hoc Networks area. The results demonstrate that Fuzzy MEBN is capable of dealing with ambiguous semantical and uncertain causal relationships between the knowledge entities very efficiently.

P712 *The Realization Problems Related to Weighted Transducers over Strong Bimonoids [#F-14094]*
Ping Li, Yongming Li and Shengling Geng, Shanxi Normal University, China; Qinghai Normal University, China
In this paper, the concepts of weighted transducers over strong bimonoids and their input-output-functions are introduced. Further more, the input-functions and output-functions induced by the input-output-functions of weighted transducers over strong bimonoids are given. It is the most important that the input-functions and output-functions of weighted transducers over strong bimonoids can be realized by weighted finite automata, and the realization does not depend on the distributive law, which also embodies the applications of weighted finite automata over strong bimonoids.

P713 *Identification of Dynamic Systems Using a Differential Evolution-Based Recurrent Fuzzy System [#F-14148]*
Cristian dos Santos, Rogerio Espindola, Vinicius Vieira and Alexandre Evsukoff, Brazilian Navy Research Institute, Brazil; Westside State University Center, Brazil; Federal University of Sao Joao Del-Rei, Brazil; Getulio Vargas Foundation, Brazil
This work presents the development of a simulation model based on a recurrent fuzzy system with structure and parameter identification by a differential evolution algorithm. The proposed model is formulated by state space equation, in which the state transition function is a recurrent fuzzy system with two feedback connections and adjustable delay operators and the output function is a linear function of the states. The identification process relies on two instances of the differential evolution algorithm in a hierarchical fashion. The outermost is considered for combinatorial structure optimization and the innermost for optimization of continuous parameters. The new model is evaluated in some benchmark problems and the results showed the model achieved good numerical performance. Moreover, the results demonstrated the ability of differential evolution algorithm to optimize both the parameters as well as the structure of the model.

P714 *Similarities in Structured Spaces of Sets [#F-14455]*
Wladyslaw Homenda and Agnieszka Jastrzebska, Warsaw University Technology, Poland
The objective of this paper is to present methodology for similarity evaluation of structured spaces of sets inspired by human cognitive processes. In contrast to classical similarity relations, which can operate only within the same space, our method can be applied to separate spaces. Proposed formulas are designed to compare two families of sets belonging to separate spaces. Unlike in set- theoretic approach to similarity present in literature, fundamental knowledge, which we use is sets and subsets cardinalities and division of spaces into subsets combined with appropriate minimum and maximum as aggregation operators. Theoretical discussion is supported with a case study, where we apply designed formulas to calculate similarities of four cities. Introduced method has been constructed after an analysis how humans perform similarity evaluation for hard to compare concepts and phenomena.

P715 *A Novel Low-Complexity Method for Determining Nonadditive Interaction Measures Based on Least-Norm Learning [#F-14531]*
Wei An, Chunxiao Ren, Song Ci, Dalei Wu, Haiyan Luo and Yanwei Liu, Chinese Academy of Sciences, China; Shandong Academy of Information and Communication Technology, China; University of Nebraska-Lincoln, United States; Massachusetts Institute of Technology, United States
Numerous research works have been done on the Choquet integral model due to the tremendous usage in many fields. However, the application is still significantly restricted by the curse of dimensionality, involved in determining the non-additive interaction measures, that can properly reflect the interactions among predictive attributes toward the objective. To this end, in this paper we propose a novel determination method for non-additive interaction measures by the way of solving a sequence of least norm problems and iteratively updating the values of interaction measures, namely least norm learning. This method can achieve a significant reduction on the computation time complexity from O(m\times 2^n) to O(mn) for solving the Choquet integral model, where m and n are the numbers of observations and attributes, respectively. Also we achieve to reduce the computation space complexity from O(m\times 2^n) to O(2^n). A case study on cross-layer optimized wireless multimedia communications is adopted to validate the proposed method. Both analytical and experimental results show the effectiveness of the proposed method.

P716 *Model Reference Adaptive Iterative Learning Control for Nonlinear Systems Using Observer Design [#F-14173]*
Ying-Chung Wang, Chiang-Ju Chien and I-Hong Jhuo, Huafan University, Taiwan; Academia Sinica, Taiwan
In this paper, we propose an observer based model reference adaptive iterative learning control (MRAILC) using model reference adaptive control strategy for more general class of uncertain nonlinear systems with non-canonical form and iteration-varying reference trajectories. Due to the system state vector is assumed to be unmeasurable, a state tracking error observer is applied for state tracking error estimation. Based on the state tracking error observer and a mixed time-domain and s-domain technique, a relative degree one output observation error model whose inputs are some uncertain nonlinearities and filtered signals which is derived to solve the relative degree problem caused by the system states are not measurable. Besides, we also apply some auxiliary signals and an averaging filter to transfer the original output observation error to a new formulation so that we can implement the AILC without using differentiators. The filtered fuzzy neural network (filtered-FNN) using the system state estimation vector as the input vector is applied for approximation of the unknown plant nonlinearities. In order to overcome the lumped uncertainties associated with function approximation error and state estimation error, a normalization signal is applied as a bounding function for designing a robust AILC. The stabilization learning component is used to guarantee the boundedness of internal signals. Based on a Lyapunov like analysis, we show that all the adjustable parameters as well as internal signals remain bounded for all iterations and the norm of output tracking error will asymptotically converge to a tunable residual set.

Thursday, July 10, 4:00PM-6:00PM

Special Session: ThF2-1 Computational Intelligence for Cognitive Robotics

Thursday, July 10, 4:00PM-6:00PM, Room: 201A, Chair: Naoyuki Kubota

4:00PM *A Reduced Classifier Ensemble Approach to Human Gesture Classification for Robotic Chinese Handwriting [#F-14197]*

Fei Chao, Yan Sun, Zhengshuai Wang, Gang Yao, Zuyuan Zhu, Changle Zhou, Qinggang Meng and Min Jiang, Xiamen University, China; Loughborough University, United Kingdom

The paper presents an approach to applying a classifier ensemble to identify human body gestures, so as to control a robot to write Chinese characters. Robotic handwriting ability requires complicated robotic control algorithms. In particular, the Chinese handwriting needs to consider the relative positions of a character's strokes. This approach derives the font information from human gestures by using a motion sensing input device. Five elementary strokes are used to form Chinese characters, and each elementary stroke is assigned to a type of human gestures. Then, a classifier ensemble is applied to identify each gesture so as to recognize the characters that gestured by the human demonstrator. The classier ensemble's size is reduced by feature selection techniques and harmony search algorithm, thereby achieving higher accuracy and smaller ensemble size. The inverse kinematics algorithm converts each stroke's trajectory to the robot's motor values that are executed by a robotic arm to draw the entire character. Experimental analysis shows that the proposed approach can allow a human to naturally and conveniently control the robot in order to write many Chinese characters.

4:20PM *Reinforcement Learning in Non-Stationary Environments: An Intrinsically Motivated Stress Based Memory Retrieval Performance (SBMRP) Model [#F-14347]*

Tiong Yew Tang, Simon Egerton and Naoyoki Kubota, Monash University Malaysia, Malaysia; Tokyo Metropolitan University, Japan

Biological systems are said to learn from both intrinsic and extrinsic motivations. Extrinsic motivations, largely based on environmental conditions, have been well explored by Reinforcement Learning (RL) methods. Less explored, and more interesting in our opinion, are the possible intrinsic motivations that may drive a learning agent. In this paper we explore such a possibility. We develop a novel intrinsic motivation model which is based on the well known Yerkes and Dodson stress curve theory and the biological principles associated with stress. We use a stress feedback loop to affect the agent's memory capacity for retrieval. The stress and memory signals are fed into a fuzzy logic system which decides upon the best action for the agent to perform against the current best action policy. Our simulated results show that our model significantly improves upon agent learning performance and stability when objectively compared against existing state-of-the-art RL approaches in non-stationary environments and can effectively deal with significantly larger problem domains.

4:40PM *A Modified EM Algorithm for Hand Gesture Segmentation in RGB-D Data [#F-14375]*

Zhaojie Ju, Yuehui Wang, Wei Zeng, Haibin Cai and Honghai Liu, University of Portsmouth, United Kingdom; Zhejiang University of Technology, China

This paper proposes a novel method with a modified Expectation-Maximisation (EM) Algorithm to segment hand gestures in the RGB-D data captured by Kinect. With the depth map and RGB image aligned by the genetic algorithm to estimate the key points from both depth and RGB images, a novel approach is proposed to refine the edge of the tracked hand gesture, which is used to segment the RGB image of the hand gestures, by applying a modified EM algorithm based on Bayesian networks. The experimental results demonstrated the modified EM algorithm effectively adjusts the RGB edges of the segmented hand gestures. The proposed methods have potential to improve the performance of hand gesture recognition in Human-Computer Interaction (HCI).

5:00PM *Grounding Spatial Relations in Natural Language by Fuzzy Representation for Human-Robot Interaction [#F-14406]*

Jiacheng Tan, Zhaojie Ju and Honghai Liu, Univeristy of Portsmouth, United Kingdom

This paper addresses the issue of grounding spatial relations in natural language for human-robot interaction and robot control. The problem is approached by identifying two set of spatial relations, the image space-based and object-centered, and expressing them as fuzzy sets to capture the ambiguity inherent to the linguistic expressions for the relations. The sizes and shades of the scene objects have also been modeled as fuzzy sets for conditioning the spatial relations. To verify the validity of our approach and test its feasibility in a natural language-based interface, we have considered the typical scenarios of using the spatial relations in simple declarative and imperative sentences and designed simple grammars for parsing such sentences. Our experiment has shown that fuzzy spatial relation analysis provides a useful way for modeling the ambiguity or imprecision of the natural language in describing spatial relations and that it is possible to use the spatial relation models to support robot control and human-robot interaction in a natural language-based interface.

5:20PM *Vowel Recognition System of Lipsynchrobot in Lips Gesture Using Neural Network [#F-14474]*

Indra Adji Sulistijono, Haikal Hakim Baiqunni, Zaqiatud Darojah and Didik Setyo Purnomo, Politeknik Elektronika Negeri Surabaya, Indonesia; PT Indonesia Epson Industry, Indonesia

In this research, we propose a system of vowel recognition on the shape of the lips using a neural network backpropagation. For recognizing the shape of the vowels in the lips by image capturing through the webcam, and then processed through image processing which includes edge detection, filtering, mouth feature extraction, integral projection and vowels recognition on the lips using a back propagation neural network. The vowel recognition results obtained at the lips of the testing process neural network based on the training data and test data. The proposed method works well. The final results obtained from this research is a system that able to detect the lips with good features, with the success of recognizing vowels using 250 training data is 70%. The output data from the vowel recognition on the lips is used as an input to Lipsynchrobot that followed the gesture of human lips.

5:40PM *Quantum-Inspired Multidirectional Associative Memory for Human-Robot Interaction System [#F-14496]*

Naoki Masuyama and Chu Kiong Loo, University of Malaya, Malaysia

Quantum-Inspired Computational Intelligence based on quantum postulates is an emerging research area that exploit the parallelism of quantum mechanics. However, existing research efforts are limited to theoretical simulations and has not been implemented in robot application. With regards as Human- Robot Interaction, associative memory become essential for mutual communication. However, associative memory always suffers from limited memory capacity and high sensitivity to noise and the ability to recall from multi-modal sensory inputs. In this paper, we propose a Quantum-Inspired Multidirectional Associative Memory. This is the first attempt to overcome these two problems effectively with robot application.

Special Session: ThF2-2 Aggregation Operators

Thursday, July 10, 4:00PM-6:00PM, Room: 201B, Chair: Simon James and Gang Li

4:00PM *"And"- and "Or"-Operations for "Double", "Triple", etc. Fuzzy Sets [#F-14118]*

Hung T. Nguyen, Vladik Kreinovich and Olga Kosheleva, New Mexico State University, United States; University of Texas at El Paso, United States

In the traditional fuzzy logic, the expert's degree of confidence d(A and B) in a complex statement "A and B" (or A\/B) is uniquely determined by his/her degrees of confidence d(A) and d(B) in the statements A and B, as fd(A),d(B)) for an appropriate "and"- operation (t-norm). In practice, for the same degrees d(A) and d(B), we may have different degrees d(A and B) depending on the relation between A and B. The best way to take this relation into account is to explicitly elicit the corresponding degrees d(A and B) and d (A\/B), i.e., to come up with "double" fuzzy sets. If we only elicit information about pairs of statements, then we still need to estimate, e.g., the degree d(A and B and C) based on the known values d(A), d(B), d(C), d(A and B), d(A and C), and d(B and C). In this paper, we explain how to produce such "and"-operations for "double" fuzzy sets and how to produce similar "or"-operations.

4:20PM *Upper and Lower Generalized Factoraggregations Based on Fuzzy Equivalence Relation [#F-14462]*

Pavels Orlovs and Svetlana Asmuss, University of Latvia, Latvia

We develop the concept of a general factoraggregation operator introduced by the authors on the basis of an equivalence relation and applied in two recent papers for analysis of bilevel linear programming solving parameters. In the paper this concept is generalized by using a fuzzy equivalence relation instead of the crisp one. By using a left-continuous t-norm and its residuum we define and investigate two modifications of such generalized construction: upper and lower generalized factoraggregations. These generalized factoraggregations can be used for construction of extensional fuzzy sets.

4:40PM *Interpolative GCD Aggregators [#F-14472]*

Jozo Dujmovic, San Francisco State University, United States

This paper investigates the structure and properties of interpolative generalized conjunction/disjunction (GCD) aggregators. The main advantage of interpolative aggregators is the possibility to include suitable properties and to exclude inconvenient properties of aggregators. Using this method we can create new forms of logic aggregators by interpolating between heterogeneous base aggregators, i.e. aggregators that belong to different families and have different logic properties. The resulting interpolative aggregators then extend the desirable properties inherited from the base aggregator classes. We propose a general interpolative GCD aggregator (IGCD) and its important uniform special case. IGCD can be used to build compound aggregators and complex logic aggregation structures with suitable logic properties.

5:00PM *Analytical Solution Methods for the Linguistic Weighted Average Problem [#F-14127]*

Xinwang Liu, Xu Yong, Tong Wu and Na Li, Southeast University, China

The linguistic weighted average (LWA) of interval type-2 fuzzy sets is an extension of the fuzzy weighted average (FWA) of type-1 fuzzy sets. Currently, the commonly used methods of both FWA and LWA are based on alpha-cuts decomposition of the type-1 of type-2 fuzzy sets, which involves large amount of calculations, and the result is not accurate. In this paper, we propose a new algorithm to obtain the analytical solution methods, which is more accurate and efficient than the current alpha-cuts methods. Some properties of the algorithms are discussed. A numerical example is used to illustrate our new proposed algorithms.

5:20PM *Nearest Neighbour-Guided Induced OWA and Its Application to Journal Ranking [#F-14419]*

Pan Su, Tianhua Chen, Changjing Shang and Qiang Shen, Aberystwyth University, United Kingdom

Aggregation operators are useful tools which summarise multiple inputs to a single output. In practice, inputs to such operators are variables which represent different criteria, measurements, or opinions from experts. In this paper, a nearest neighbour-guided induced OWA operator, abbreviated as kNN-IOWA, is proposed as a special case of the generic induced OWA where the input arguments are ordered by the average distances to their k nearest neighbours. The weighting vectors in kNN-IOWA are defined, which are used to interpret the overall behaviour of the operator's reliability. kNN-IOWA is applied for building aggregated fuzzy relations between academic journals, based on their indicator scores. It combines the similarities between academic journals to assess their performance with respect to different journal impact indicators. The work is compared against different types of aggregation operator and tested on six bibliometric datasets. The results of experimental evaluation demonstrate that kNN-IOWA outperforms other aggregation operators in terms of standard accuracy and within-1 accuracy. The proposed method also exhibits the advantages of being more intuitive and interpretable.

5:40PM *Worker Ranking Determination in Crowdsourcing Platforms Using Aggregation Functions [#F-14424]*

David Sanchez-Charles, Jordi Nin, March Sole and Victor Muntes-Mulero, CA Labs, Spain; BSC-CNS, UPC-BarcelonaTech, Spain; UPC-Barcelona Tech, Spain

The increasing adoption of crowdsourcing for commercial and industrial purposes rises the need for creating sophisticated mechanisms in crowd-based digital platforms for efficient worker management. One of the main challenges in this area is worker motivation and skill set control and its impact on the output quality. The quality delivered by the workers in the crowd depends on different aspects such as their skills, experience, commitment, etc. The lack of generic and detailed proposals to incentive workers and the need for creating ad-hoc solutions depending on the domain make it difficult to evaluate the best rewarding functions in each scenario. In this paper, we make a step further in this direction and propose the use of aggregation functions to evaluate the professional skills of crowd- workers based on the quality of their past tasks. Additionally, we present a real industrial crowdsourcing solution for software localisation in which the proposed solutions are put into practice with real text translations quality measures.

Special Session: ThF2-3 Paradigms of Fuzzy Systems for Medical Benefits

Thursday, July 10, 4:00PM-6:00PM, Room: 201C, Chair: Syoji Kobashi and Md. Atiqur Rahman Ahad

4:00PM *Fuzzy Object Growth Model for Newborn Brain Using Manifold Learning [#F-14187]*

Ryosuke Nakano, Syoji Kobashi, Kei Kuramoto, Yuki Wakata, Kumiko Ando, Reiichi Ishikura, Tomomoto Ishikawa, Shozo Hirota and Yutaka Hata, University of Hyogo, Japan; Hyogo Collage of Medicine, Japan; Ishikawa Hospital, Japan

To develop a computer-aided diagnosis system for neonatal cerebral disorders, some literatures have shown atlas-based methods for segmenting parenchymal region in MR images. Because neonatal cerebrum deforms quickly by natural growth, we desire an atlas growth model to improve the accuracy of segmenting parenchymal region. This paper proposes a method for generating fuzzy object growth model (FOGM), which is an extension of fuzzy object model (FOM). FOGM is composed of some growth index weighted FOMs. To define the growth index, this paper introduces two methods. The first method calculates the growth index from revised age. Because the growth index will be different from person to person even through the same age, the second method estimates the growth index from cerebral shape using Manifold learning. To evaluate the proposed methods, we segment the parenchymal region of 16 subjects (revised age; 0-2 years old) using the synthesized FOGM. The results showed that FOGM was superior to FOM, and the Manifold learning based method gave the best accuracy. And, the growth index estimated with Manifold learning was significantly correlated with both of revised age and cerebral volume ($p<0.001$).

4:20PM *Investigating Distance Metric Learning in Semi-Supervised Fuzzy C-Means Clustering [#F-14220]*

Daphne Teck Ching Lai, Jonathan Garibaldi and Jenna Reps, University of Nottingham, United Kingdom

The idea behind distance metric learning (DML) is to accentuate the distance relations found in the training data, maintaining whether the data patterns are similar or dissimilar. In this paper, we investigate in using DML (GDML, LMNN, MCML and NCA) in semi-supervised Fuzzy c-means clustering and apply them on a real, biomedical dataset and on UCI datasets. We used a cross validation setting with varying amount of labelled data to test our methodology. Out of eight datasets, statistical significant improvement was found on five datasets using ssFCM with DML. This shows that DML can improve ssFCM clustering for some datasets. Further analysis using 2D PCA projection and sum of squared distances before and after DML transformation of the original data are carried out. Interestingly, DML was found to worsen ssFCM clustering in the NTBC dataset with hierarchical clusters.

4:40PM *Soft Class Decision for Nursing-Care Text Classification Using a K-Nearest Neighbor Based System [#F-14321]*

Manabu Nii, Kazunobu Takahama, Atsuko Uchinuno and Reiko Sakashita, University of Hyogo, Japan

In the aging society such as Japan, it is very important to improve the quality of nursing-care for keeping our quality of life. Our final goal is to develop a computer aided evaluation system to improve the quality of nursing-care. For evaluating the quality of actual nursing, we have been collecting texts that are written by nurses using our Web based system. In our previous works, a SVM based classification system has been developed to classify such nursing-care texts, and a dependency relation based feature vector definition has also been proposed. The training data are pre-classified texts by a few nursing-care experts. Some texts in the training data are similar but classified into different classes. To classify the nursing-care texts with high accuracy, we need to tackle such ambiguous class labels in the training data. In this paper, we propose a k-nearest neighbor based classification system which can classify into classes with certainty grade.

5:00PM *An Automated Determination of Blumensaat Line Using Fuzzy System Based on Physician Experience from Femur CT Image [#F-14325]*

Yosuke Uozumi, Kouki Nagamune, Naoki Nakano, Kanto Nagai, Yuichiro Nishizawa, Yuichi Hoshino, Takehiko Matsushita, Ryosuke Kuroda and Masahiro Kurosaka, University of Fukui, Japan; Kobe University, Japan

Blumensaat line is one of the most commonly used direct methods for the assessment of femoral diagnosis and therapy. Currently, the Blumensaat line is determined manually. Therefore, diversity of the determination happens due to the subjective judgment error. To reduce the diversity, we propose an automated determination of Blumensaat line by using fuzzy logic based on physician knowledge from femur multi-detector row computerized tomography (MDCT) image. The experiment employed six different knees. The six femurs were evaluated by the manual and proposed method. In the results, the length of Blumensaat line was 24.12 +/- 3.23 mm (manual) and 23.90 +/- 2.41 mm (automated). The angle between Blumensaat line and bone axis was 27.80 +/- 6.08 degrees (manual) and 30.68 +/- 5.76 degrees (automated). There was no significant difference between the manual and proposed method. We concluded that the proposed method has enough accuracy as same as expert.

5:20PM *Multimodeling for the Prediction of Patient Readmissions in Intensive Care Units [#F-14379]*

Marta Fernandes, Claudia Silva, Susana Vieira and Joao Sousa, Instituto Superior Tecnico, Portugal

The aim of this work is to identify groups of patients with similar patterns that are related to a higher risk of readmission to an Intensive Care Unit (ICU). Patients readmissions to ICUs are introduced as a problem associated with increased mortality, morbidity and costs, which complicates the performance of a good clinical management and medical diagnosis. To approach the readmissions classification problem, Fuzzy C-Means (FCM) clustering algorithm was implemented to find the different groups of patients. A multimodel approach was developed using these groups and the best clustering division was assessed through different objective functions. Two decision criteria were used for the multimodel approach, an a priori decision and an a posteriori decision. The data used, from MIMIC II database, consisted on the arithmetic means of time series of variables - acquired during the last 24 hours before discharge. The multimodel using the a priori and the a posteriori decisions were able to predict readmissions with an average AUC of 0.74 and 0.75, respectively. Consequently, the multimodel results overcame the results of previous predictive models developed for the classification of readmissions outcome.

5:40PM *Benefits of Fuzzy Logic in the Assessment of Intellectual Disability [#F-14461]*

Alessandro Di Nuovo, Santo Di Nuovo, Serafino Buono and Vincenzo Cutello, Plymouth University, United Kingdom; Catania University, Italy; IRCCS Oasi di Troina, Italy

Among the artificial intelligence techniques, that successfully support computer assisted decision making, fuzzy logic has proved to be a powerful tool in various fields and in particular it is appreciated by clinical practitioners because of their approaches to take a decision require to deal with uncertainties and vagueness in the knowledge and information. Thus, one field in which fuzzy sets theory can be applied with great benefit is psychopathology, due to the high prominence of sources of uncertainty that should be taken into account when the diagnosis of intellectual disability must be formulated. Indeed clinical psychologists have often to deal with comorbidities that make the decision process harder because they must evaluate different assessment tools for a correct diagnosis. In our work we investigate the application of computational intelligence and in particular of approaches based on fuzzy logic and its hybridizations in the psychological assessment by means of theoretical studies and practical experiments with data collected from patients affected by different levels of intellectual

disability, under treatment in a clinical center. In this paper we present a detailed review of the experimental application of methodologies we propose to generate fuzzy expert systems for the assessment of intellectual disability. Specifically we highlight with numerical results how they can be beneficial for the diagnosis and improve efficacy of the administration of psycho-diagnostic instruments and the efficiency of the assessment.

Special Session: ThF2-4 Advances to Self-tuning and Adaptive Fuzzy Control Systems

Thursday, July 10, 4:00PM-6:00PM, Room: 201D, Chair: Tsung-Chih Lin

4:00PM *Model-Based Takagi-Sugeno Fuzzy Approach for Vehicle Longitudinal Velocity Estimation during Braking [#F-14050]*

Haiping Du and Weihua Li, University of Wollongong, Australia

Accurate vehicle longitudinal velocity estimation is important for wheel slip ratio control in antilock braking systems. To overcome the problem of nonlinear tyreroad friction characteristic when designing an observer for velocity estimation, this paper presents a novel approach by using the model-based fuzzy technique. The nonlinear vehicle braking system is modelled by a Takagi-Sugeno fuzzy model first. A fuzzy observer is then constructed by using the available measurements of wheel angular velocity and braking torque with the estimated premise variables. All the possible disturbances and uncertainties are considered so that the designed observer is robust under an Hinf; performance index from the disturbances to the estimation error. The design of the observer is achieved by solving a set of linear matrix inequalities. Numerical simulations on a quartervehicle braking model are used to validate the effectiveness of the proposed approach.

4:20PM *Analysis of the Performances of Type-1, Self-Tuning Type-1 and Interval Type-2 Fuzzy PID Controllers on the Magnetic Levitation System [#F-14138]*

Ahmet Sakalli, Tufan Kumbasar, Engin Yesil and Hani Hagras, Istanbul Technical University, Turkey; University of Essex, United Kingdom

In this paper, we will compare the closed loop control performance of interval type-2 fuzzy PID controller with the type-1 fuzzy PID and conventional PID controllers counterparts for the Magnetic Levitation Plant. We will also compare the control performance of the interval type-2 fuzzy PID controller with the self-tuning type-1 fuzzy PID controllers. The internal structures of implemented controllers are firstly examined and then the design parameters of each controller are optimized for a given reference trajectory. The paper also show the effect of the extra degree of freedom provided by antecedent membership functions of interval type-2 fuzzy logic controller on the closed loop system performance. The real-time experiments are accomplished on an unstable nonlinear system, QUANSER Magnetic Levitation Plant, in order to show the superiority of the optimized interval type-2 fuzzy PID controller compared to optimized PID and type-1 counterparts. Keywords--Interval type-2 fuzzy PID controllers; self-tuning; magnetic levitation system.

4:40PM *Robust Stabilization of Recurrent Fuzzy Systems via Switching Control [#F-14189]*

Stefan Gering, Wolfgang Krippner and Juergen Adamy, TU Darmstadt, Germany

A method for stabilization of known equilibria in recurrent fuzzy systems is presented, which particularly accounts for model uncertainties. Since the dynamics of recurrent fuzzy systems are defined over a rectangular grid, it is first observed that for stability analysis, only gradient conditions at grid points have to be considered given that the inputs are piecewise constant. Therefore, a robust structure variable controller is proposed, switching between constant inputs. In order to prevent the system from deadlock phenomena due to the switching of the system, the structure variable control is augmented by a piecewise polynomial controller, guaranteeing asymptotic stability. The proposed method is applied to the example of an inverted pendulum.

5:00PM *Performance Evaluation of Interval Type-2 and Online Rule Weighing Based Type-1 Fuzzy PID Controllers on a PH Process [#F-14154]*

Tufan Kumbasar, Cihan Ozturk, Engin Yesil and Hani Hagras, Istanbul Technical University, Turkey; University of Essex, United Kingdom

In this paper, we will explore whether the efficiency of the Interval Type-2 Fuzzy PID (IT2-FPID) lies in its ability to handle the high level of uncertainties rather than only having an extra degree of freedom provided by the Footprint of Uncertainty (FOU) on a highly nonlinear pH neutralization process. In order to illustrate the effect of the FOU on the control performance, the control performance of an IT2-FPID controller composed of 3x3 rules will be compared with a Type-1 Fuzzy PID (T1-FPID) controller of 5x5 rules. Moreover, in order to provide more extra degree of freedom to the T1-FPID structure, we will employ two self-tuning mechanisms where the weights of the fuzzy rules are adjusted in an online manner. Thus, we will present detailed comparative studies on how the extra degrees of freedom provided by the FOU or the employed tuning mechanisms affect the control and robustness performance. The presented analysis confirm that by tuning the FOU the performance of the IT2-FPID is better in wide range of operating points in comparison with its type-1 and self-tuning type-1 fuzzy counterparts which is not merely for the IT2-FPID use of extra parameters, but rather its different way of dealing with the disturbance, nonlinearities uncertainties and noise. Keywords--Interval type-2 fuzzy PID controllers; extra degress of freedom; pH neutralization model.

5:20PM *Observer-Based Indirect Adaptive Supervisory Control for Unknown Time Delay System [#F-14164]*

Ting-Ching Chu, Tsung-Chih Lin and Valentina Emilia Balas, Feng-Chia University, Taiwan; University of Arad, Romania

This paper proposes an indirect adaptive fuzzy neural network controller with state observer and supervisory controller for a class of uncertain nonlinear dynamic time-delay systems. The approximate function of unknown time delay system is inferred by the adaptive time delay fuzzy logic system. The supervisory controller, which can be combined with fuzzy neural network controller, will work when error dynamics is great than a constant which is determined by designer. Therefore, if the system is unstable, the supervisory controller will force the state to be stable. The free parameters of the indirect adaptive fuzzy controller can be tuned on-line by observer based output feedback control law and adaptive laws by means of Lyapunov stability criterion. The resulting of simulation example shows that the performance of nonlinear time-delay chaotic system is fully tracking the reference trajectory. Meanwhile simulation results show that the adaptive control effort of the proposed control scheme is much less due to the assist of the supervisory controller.

5:40PM *Direct Adaptive Fuzzy Tracking Control with Observer and Supervisory Controller for Nonlinear MIMO Time Delay Systems [#F-14312]*

Chia-Hao Kuo, Tsung-Chih Lin and Chien-Liang Chen, Feng Chia University, Taiwan

This paper proposes a direct adaptive fuzzy control with observer and supervisory controller for uncertain multiple-input multiple-output (MIMO) nonlinear dynamical systems. Since time delays and external disturbances probably are sources of unstable for the system, by combining H control theory and fuzzy control to make both fuzzy logic approximation error and

external disturbance on the track error are attenuated to a prescribed level. Based on Lyaounov stability criterion, the parameters of the adaptive fuzzy controller can be tuned online by control law and adaptive law. Simulation results show that effectiveness and track performance are acceptable.

Friday, July 11, 8:10AM-10:10AM

Special Session: FrF1-1 Handling Uncertainties in Big Data by Fuzzy Systems

Friday, July 11, 8:10AM-10:10AM, Room: 201A, Chair: Jie Lu

8:10AM *A Fuzzy Tree Matching-Based Personalised E-Learning Recommender System [#F-14113]*

Dianshuang Wu, Guangquan Zhang and Jie Lu, University of Technology, Sydney, Australia

The rapid development of e-learning systems provides learners great opportunities to access the learning activities online, which greatly supports and enhances learning practices. However, too many learning activities are emerging in the e-learning system, which makes it difficult for learners to select proper ones for their particular situations since there is no personalised service function. Recommender systems, which aim to provide personalised recommendations, can be used to solve this issue. However, e-learning systems have two features to handle: (1) data of learners and leaning activities often present tree structures; (2) data are often vague and uncertain in practice. In this study, a fuzzy tree-structured data model is proposed to comprehensively describe the complex learning activities and learner profiles. A tree matching method is then developed to match the similar learning activities or learners. To deal with the uncertain category issues, a fuzzy category tree and relevant similarity measure are developed. A hybrid recommendation approach, which considers precedence relations between learning activities and combines the semantic and collaborative filtering similarities between learners, is developed. The proposed approach can handle the special requirements in e-learning environment and make proper recommendations in e-learning systems.

8:30AM *On the Use of Map-Reduce to Build Linguistic Fuzzy Rule Based Classification Systems for Big Data [#F-14342]*

Victoria Lopez, Sara Del Rio, Jose Manuel Benitez and Francisco Herrera, University of Granada, Spain

Big data has become one of the emergent topics when learning from data is involved. The notorious increment in the data generation has directed the attention towards the obtaining of effective models that are able to analyze and extract knowledge from these colossal data sources. However, the vast amount of data, the variety of the sources and the need for an immediate intelligent response pose a critical challenge to traditional learning algorithms. To be able to deal with big data, we propose the usage of a linguistic fuzzy rule based classification system, which we have called Chi-FRBCS-BigData. As a fuzzy method, it is able deal with the uncertainty that is inherent to the variety and veracity of big data and because of the usage of linguistic fuzzy rules it is able to provide an interpretable and effective classification model. This method is based on the MapReduce framework, one of the most popular approaches for big data nowadays, and has been developed in two different versions: Chi-FRBCS-BigData-Max and Chi-FRBCS-BigData-Ave. The good performance of the Chi-FRBCS-BigData approach is supported by means of an experimental study over six big data problems. The results show that the proposal is able to provide competitive results, obtaining more precise but slower models in the Chi-FRBCS-BigData-Ave alternative and faster but less accurate classification results for Chi-FRBCS-BigData-Max.

8:50AM *A Trust-Based Performance Measurement Modeling Using DEA, T-Norm and S-Norm Operators [#F-14526]*

Ali Azadeh, Saeed Abdolhosseinzadeh, Morteza Saberi, Farookh Khadeer Hussain and Omar Khadeer Hussain, University of Tehran, Iran; University of Technology Sydney, Australia; University of New South Wales, Australia

In today's highly dynamic economy and society, the performance evaluation of Decision Making Units (DMUs) is of high importance. This study presents an efficient model for analyzing the outputs of performance measurement methodologies by means of trust, which provides explicit qualitative scales instead of representing pure numerical data. The efficiency rate of the current, previous and coming years, as well as the average efficiency and standard deviation, are the five inputs for this model. These efficiency rates are calculated using Data Envelopment Analysis (DEA). The approach uses time series forecasting to predict the future efficiency rate. Furthermore, the implemented Auto Regressive (AR) model includes an Auto Correlation Function (ACF) for input selection. The model utilizes T-norms and S-norms as the final modeling tools. To illustrate the applicability of the proposed model, we apply it to a data set of DMUs. Ultimately, modified trust values for these DMUs are determined using the proposed approach

9:10AM *A Novel Evaluation Approach for Power Distribution System Planning Based on Linear Programming Model and ELECTRE III [#F-14253]*

Tiefeng Zhang, Guangquan Zhang, Jie Lu and Jianwei Gu, North China Electric Power University, China; University of Technology, Sydney, Australia; Hangzhou Power Supply Company, China

To evaluate solutions of power distribution system planning (PDSP) is an essential task in smart grid and requires multi-criteria decision making (MCDM). However, the vagueness of attribute values and the fuzziness of weights of criteria need integrate fuzzy techniques with MCDM. In order to incorporate the issues with uncertainty in PDSP evaluation, this paper proposes a novel PDSP approach based on linear programming model and ELECTRE III. The incomplete weight preference information of decision-maker is elicited and expressed by a group of weight constraint functions, combined these functions with the simple multi-attribute rating technique , a linear programming model is set up to obtain the weights for each solution. Then with the weights and a PDSP model based on ELECTRE III model, the outranking score of each solution compared with other solutions can be calculated, and a net present score for each solution will be obtained for ranking these solutions, DM can choose one desired. A case is demonstrated to show the evaluation process using this approach and the results indicate that this approach incorporating the issues with uncertainty is robust for PDSP evaluation. The results are acceptable to DM.

9:30AM *Multicriteria Decision Making with Fuzziness and Criteria Interdependence in Cloud Service Selection [#F-14551]*

Le Sun, Hai Dong, Farookh Hussain, Omar Hussain, Jiangang Ma and Yanchun Zhang, Victoria University, Australia; RMIT University, Australia; University of Technology, Sydney, Australia; University of New South Wales, Australia

With the advent of Cloud computing and subsequent big data, online decision makers usually find it difficult to make informed decisions because of the great amount of irrelevant, uncertain, or inaccurate information. In this paper, we explore the application of multicriteria decision-making (MCDM) techniques in the area of Cloud computing and big data, to find an efficient way of dealing with criteria relations and fuzzy knowledge based on a great deal of information. We propose a MCDM framework, which combines the ISM-based and ANP-based techniques, to model the interactive relations between evaluation criteria, and to handle data uncertainties. We present an application of Cloud service selection to prove the efficiency of the proposed framework, in which a user-oriented sigmoid utility function is designed to evaluate the performance of each criterion.

9:50AM *Medical Diagnosis by Fuzzy Standard Additive Model with Wavelets [#F-14500]*

Thanh Nguyen, Abbas Khosravi, Douglas Creighton and Saeid Nahavandi, Deakin University, Australia

This paper proposes a combination of fuzzy standard additive model (SAM) with wavelet features for medical diagnosis. Wavelet transformation is used to reduce the dimension of high-dimensional datasets. This helps to improve the convergence speed of supervised learning process of the fuzzy SAM, which has a heavy computational burden in high-dimensional data. Fuzzy SAM becomes highly capable when deployed with wavelet features. This combination remarkably reduces its computational training burden. The performance of the proposed methodology is examined for two frequently used medical datasets: the lump breast cancer and heart disease. Experiments are deployed with a five-fold cross validation. Results demonstrate the superiority of the proposed method compared to other machine learning methods including probabilistic neural network, support vector machine, fuzzy ARTMAP, and adaptive neuro-fuzzy inference system. Faster convergence but higher accuracy shows a win-win solution of the proposed approach.

Special Session: FrF1-2 Evolutionary Fuzzy Systems

Friday, July 11, 8:10AM-10:10AM, Room: 201B, Chair: Yusuke Nojima

8:10AM *Aeroengine Prognosis through Genetic Distal Learning Applied to Uncertain Engine Health Monitoring Data [#F-14226]*

Alvaro Martinez, Luciano Sanchez and Ines Couso, Rolls-Royce Deutschland Ltd, Germany; Universidad de Oviedo, Spain

Genetic Fuzzy Systems have been successfully applied to assess Engine Health Monitoring (EHM) data from aeroengines, not only due to their robustness towards noisy gas path measurements and engine-to-engine variability, but also because of their capability to produce human-readable expressions. These techniques can detect the presence of certain types of abnormal events or specific engine conditions, where a combination of the EHM signals only appears when these occur. However, an engine that repeatedly operates under unfavourable conditions will also have a reduced life. Smooth deteriorations do no manifest themselves as combinations of the EHM signals, the current existing techniques can therefore not assess these. In this paper it is proposed to use distal learning to build a model that indirectly identifies the deterioration rate of an aeroengine. It will be shown that the integral of the modelled rate is a prognostic indicator of the remaining life of the engine to a selected end condition. The results are subsequently tested on a representative sample of aeroengine data.

8:30AM *GPFIS-Control: A Fuzzy Genetic Model for Control Tasks [#F-14313]*

Adriano Koshiyama, Tatiana Escovedo, Marley Vellasco and Ricardo Tanscheit, Pontifical Catholic University of Rio de Janeiro, Brazil

This work presents a Genetic Fuzzy Controller (GFC), called Genetic Programming Fuzzy Inference System for Control tasks (GPFIS-Control). This GFC is based on Multi-Gene Genetic Programming, a variant of canonical Genetic Programming. We describe the main characteristics and concepts of this approach, as well as its distinctions from other GFCs. Two benchmarks application of GPFIS-Control are considered: the Cart-Centering Problem and the Inverted Pendulum. In both cases the results, when compared to other GFCs in the literature, demonstrate the superiority and potentialities of GPFIS-Control.

8:50AM *Tuning Larger Membership Grades for Fuzzy Association Rules [#F-14358]*

Stephen G. Matthews, University of Bristol, United Kingdom

Sigma count measures scalar cardinality of fuzzy sets. A problem with sigma count is that values of scalar cardinality are calculated entirely from many small membership grades or entirely from few large membership grades. Two novel scalar cardinality measures are proposed for the fitness of a genetic algorithm for tuning membership functions prior to fuzzy association rule mining so that individual membership grades are larger. Preliminary results show a decrease in small membership grades and an increase in large membership grades for fuzzy association rules tested on real-world benchmark datasets.

9:10AM *Embedding Evolutionary Multiobjective Optimization into Fuzzy Linguistic Combination Method for Fuzzy Rule-Based Classifier Ensembles [#F-14473]*

Krzysztof Trawinski, Oscar Cordon and Arnaud Quirin, European Centre for Soft Computing, Spain; Galician Research and Development Center in Advanced Telecommunications, Spain

In a preceding contribution, we proposed a novel combination method by means of a fuzzy linguistic rule- based classification system. The fuzzy linguistic combination method was based on a genetic fuzzy system in order to learn its parameters from data. By doing so the resulting classifier ensemble was able to show a hierarchical structure and the operation of the latter component was transparent to the user. In addition, for the specific case of fuzzy classifier ensembles, the new approach allowed fuzzy classifiers to deal with high dimensional classification problems avoiding the curse of dimensionality. However, this approach strongly depended on one parameter defining the complexity of the final classifier ensemble and in consequence affecting the final accuracy. To avoid this tedious problem, we propose to automatically derive this parameter. For this purpose, we use the most common evo- lutionary multiobjective algorithm, namely NSGA-II, in order to optimize two criteria, complexity and accuracy. We carry out comprehensive experiments considering 20 UCI datasets with different dimensionality, showing the good performance of the proposed approach.

9:30AM *Spectral-Spatial Classification of Remote Sensing Images Using a Region-Based GeneSIS Segmentation Algorithm [#F-14146]*

Stelios Mylonas, Dimitris Stavrakoudis, John Theocharis and Paris Mastorocostas, Aristotle University of Thessaloniki, Greece; Technological Education Institute of Central Macedonia, Greece

This paper proposes a spectral-spatial classification scheme for the classification of remotely sensed images, based on a new version of the recently proposed Genetic Sequential Image Segmentation (GeneSIS). GeneSIS segments the image in an iterative manner, whereby at each iteration a single object is extracted via a genetic algorithm-based object extraction method. In the previous version of GeneSIS, the candidate objects to be extracted were evaluated through the fuzzy content of their included pixels. In the present proposal, a watershed-driven fine segmentation map is initially obtained which serves as the basis for the upcoming GeneSIS segmentation. Our objective is to enhance the flexibility of the algorithm in extracting more flexible object shapes and reduce the execution time of the segmentation, while at the same time preserving all the inherent attributes of the GeneSIS procedure. Accordingly, the previously proposed fitness components are redefined in order to accommodate with the new structural components. In this work, the set of fuzzy membership maps required by GeneSIS are obtained via an unsupervised fuzzy clustering. The final classification result is obtained by combining the results from the unsupervised segmentation and the pixel-wise SVM classifier via majority voting. The validity of the proposed method is demonstrated on the land cover classification of a high-resolution hyperspectral image.

9:50AM *Genetic-Fuzzy Mining with Type-2 Membership Functions [#F-14404]*

Yu Li, Chun-Hao Chen, Tzung-Pei Hong and Yeong-Chyi Lee, National Sun Yat-sen University, Taiwan; Tamkang University, Taiwan; National University of Kaohsiung, Taiwan; Cheng Shiu University, Taiwan

In this paper, a type-2 genetic-fuzzy mining algorithm is proposed for mining a set of type-2 membership functions for mining fuzzy association rules. It first encodes the type-2 membership functions of each item into a chromosome. The quantitative transactions are then transformed into fuzzy values according to the type-2 membership functions. Each chromosome is then evaluated by the number of large 1-itemsets and the suitability factor. The suitability factor consists of three sub-factors - coverage, overlap and difference which are used to avoid three bad types of membership functions. Experiments on a simulated dataset are also conducted to show the effectiveness of the proposed approach.

FrF1-3 Fuzzy Control and Intelligent Systems III

Friday, July 11, 8:10AM-10:10AM, Room: 201C, Chair: Shan Xu and Chun-Hsiung Fang

8:10AM *Local H Infinity Control and Invariant Set Analysis for Continuous-Time T-S Fuzzy Systems with Magnitude- and Energy-Bounded Disturbances [#F-14027]*

Dong Hwan Lee, Young Hoon Joo and Myung Hwan Tak, Yonsei University, Korea (South); Kunsan National University, Korea (South)

This paper addresses local H-infinity controller design problems for continuous- time Takagi-Sugeno (T-S) systems with magnitude- and energy-bounded disturbances. The design procedure is formulated as optimizations subject to linear matrix inequalities (LMIs) which can be solved by means of convex optimization techniques. The designed controllers not only guarantee the H-infinity performance but also ensure the state not to escape an invariant set that is included by the region where the T-S fuzzy model is defined. Finally, examples are given to illustrate the proposed method.

8:30AM *Design of Indirect Adaptive Fuzzy Control (IAFC) for Nonlinear Hysteretic Systems [#F-14063]*

Chi-Hsu Wang, Jyun-Hong Wang and Chun-Yao Chen, National Chiao Tung University, Taiwan

Nonlinear hysteretic phenomena occur in many physical systems, such as electronic throttle and solenoid valves in automobiles, piezoelectric sensors, and many other mechanical actuators. In order to handle the nonlinear properties of hysteretic systems, an indirect adaptive fuzzy controller (IAFC) is proposed in this paper. However, it is a hard task to directly identify unknown hysteretic effects. Firstly, to overcome this problem, a hysteretic function is employed to construct the nonlinear properties of backlash-like hysteretic systems. Then the existence of an indirect adaptive controller (IAFC) is derived in this paper. Unlike the existing fuzzy control methods, our proposed IAFC can deal with different kinds of hysteretic problems with adaptive and control laws. Based on the learning algorithm, the adaptive and control laws not only can be derived but the stability of the closed-loop system can also be guaranteed by the Lyapunov stability criterion. Finally, MATLAB software is used for simulations, and the results show that our proposed IAFC can effectively handle the nonlinear properties in some unknown hysteretic systems.

8:50AM *Optimal Finite-Horizon Control with Disturbance Attenuation for Uncertain Discrete-Time T-S Fuzzy Model Based Systems [#F-14067]*

Wen-Ren Horng, Jyh-Horng Chou and Chun-Hsiung Fang, National Kaohsiung University of Applied Sciences, Taiwan

In this paper, the sufficiency condition for disturbance attenuation level for uncertain discrete-time T-S fuzzy model-based system is derived by non-quadratic Lypaunov function (NQLF) and is expressed in terms of LMIs. And the quadratic finite horizon performance index optimal robust control with disturbance attenuation level for uncertain T-S fuzzy system can be formulated into static constrained optimization problem. Then, for static constrained optimization problem, the genetic algorithm is employed to search feedback gain for optimal finite quadratic performance index of uncertain discrete-time TS fuzzy model. Thus, the problem solving can be greatly simplified

9:10AM *Distributed Fuzzy Proportional-Spatial Integral Control Design for a Class of Nonlinear Distributed Parameter Systems [#F-14091]*

Jun-Wei Wang, Huai-Ning Wu, Yao Yu and Chang-Yin Sun, University of Science and Technology Beijing, China; Beihang University, China

The fuzzy feedback control design problem is addressed in this paper by using the distributed proportional- spatial integral (P-sI) control approach for a class of nonlinear distributed parameter systems represented by semi-linear parabolic partial differential-integral equations (PDIEs). The objective of this paper is to develop a fuzzy distributed P-sI controller for the semi-linear parabolic PDIE system such that the resulting closed-loop system is exponentially stable. To do this, the semi-linear parabolic PDIE system is first assumed to be exactly represented by a Takagi-Sugeno (T-S) fuzzy parabolic PDIE model. A new vector-valued integral inequality is established via the vector- valued Wirtinger's inequality. Then, based on the T-S fuzzy PDIE model and this new integral inequality, a distributed fuzzy P-sI state feedback controller is proposed such that the closed-loop PDIE system is exponentially stable. The sufficient condition on the existence of this fuzzy controller is given in terms of a set of standard linear matrix inequalities (LMIs), which can be effectively solved by using the existing convex optimization techniques. Finally, the developed design methodology is successfully applied to solve the feedback control design of a semi-linear reaction-diffusion system with a spatial integral term.

9:30AM *Development and Implementation of Fuzzy, Fuzzy PID and LQR Controllers for an Roll-Plane Active Hydraulically Interconnected Suspension [#F-14100]*

Sangzhi Zhu, Nong Zhang and Haiping Du, University of Technology Sydney, Australia; University of Wollongong, Australia

A new safety-oriented roll plane active Hydraulically Interconnected Suspension (HIS) has been developed to compensate the limitations of conventional active suspensions such as expensive cost and high energy consumption. Active HIS is constructed by two hydraulic circuits crossing-connected between front and rear actuators at each side. The four actuators are mounted between the wheel hub and a roll plane of vehicle and powered by a hydraulic pressure unit through the hydraulic interconnected pipes. This configuration of suspension allows the controls of rolling motion of vehicle under external disturbances such as ground input causing by road roughness and/or lateral excitation due turning manoeuvre.In this paper, the mechanism of proposed active HIS system has been briefly introduced. Fuzzy Logic Control, Fuzzy proportional-integral-derivative (PID) control and optimal linear quadratic regulator (LQR) theory have been adopted to control vehicle body's roll motion. A combination of a half-car model and the active suspension model is then derived through their mechanical- hydraulic coupling in the cylinders for the model based LQR control. Three controllers have been developed and implemented in Simulink. Two different road excitations have been used to validate the robustness of the designed controllers. The effectiveness of all these three controllers has been verified by the simulation results with considerable roll angle reductions, but Fuzzy PID controller shows better effect and stability than other two controllers.

9:50AM *New Fuzzy Model with Second Order Terms for the Design of a Predictive Control Strategy [#F-14102]*

Leonel Gutierrez, Felipe Valencia, Doris Saez and Alejandro Marquez, Solar Energy Research Center, SERC-Chile, Chile; Universidad Nacional de Colombia, Colombia

In this paper a novel predictive control scheme based on Takagi-Sugeno model whose consequences include second order terms is proposed. Fuzzy models are used in order to approximate the non-linear behavior present on industrial dynamic systems. Quadratic approximations are used in the consequences because several systems has restricted controllable regions in the states domain. Thus, even fuzzy models may not be enough for representing the system dynamics in that regions, producing unexpected closed loop-behavior and loss of performance. The main difference between the proposed scheme and the ones reported in the literature is that iterative procedures and/or point to point approximation is not required. Reducing the computational burden of the controller. A continuous stirred tank reactor is used for testing the proposed control scheme.

10:10AM *A Self-Tuning Fuzzy PID Controller Design Using Gamma Aggregation Operator [#F-14119]*

Engin Yesil and Cagri Guzay, Istanbul Technical University, Turkey

In this paper, a novel tuning approach for aggregation operator of a fuzzy PID controller has been proposed. The gamma operator which has a free parameter (gamma) is used for the aggregation purpose. The change of the gamma parameter between 0 and 1 generates the aggregation operator hybrid output of the AND and OR operators. In this manner, firstly, the effect of the gamma parameter change on the control surface of the fuzzy PID controller and the closed loop system response are studied. Secondly, a gamma tuning mechanism is built by a fuzzy logic decision mechanism using the observations from the first various simulation studies. The aim of the gamma tuning mechanism is to change the gamma parameter in an online manner to obtain a fast response with no or less overshoot. The benefit of the proposed approach over the conventional aggregation operator is shown on a non-linear system via simulations. Simulations are performed in Matlab, and the performance of the proposed approach is studied for a sequence of different set-points in order to observe the set-point following performances. Moreover, the disturbance rejection performance is studied. The results of the simulations show the advantage of the proposed new self-tuning structure over the conventional structures.

FrF1-4 Fuzzy Data Mining and Forecasting

Friday, July 11, 8:10AM-10:10AM, Room: 201D, Chair: Mika Sato-Ilic and Meng Yuan

8:10AM *Fuzzy Community Detection in Social Networks Using a Genetic Algortihm [#F-14133]*

Jianhai Su and Timothy Havens, Michigan Technological University, United States

Community structure in a network usually is an indicator of some important hidden patten, and thus can deepen our understandings of some phenomenon and also enable useful applications. Even though the introduction of Newman's modularity stimulates a magnitude of modularity-based community detection methods, only a few of them are designed for uncovering fuzzy overlapping communities in a network, which in practice are really common in social networks. Considering that modularity maximization is NP- hard and that a genetic algorithm's ability to find fairly good solutions of an NP-hard problem, an O(n^2) genetic algorithm for fuzzy community detection (GAFCD) is proposed based on the generalized modularity, a one-step extension of Newman's modularity. Crossover in GAFCD works as an outer-layer search framework that statistically determines sub search spaces with which a novel mutation operator finds the best partition in each sub search space. We compare our proposed GAFCD method with an existing fuzzy community detection algorithm, MULTICUT spectral FCM (MSFCM), and GALS, one of the most effective disjoint (or crisp) community detection, on 10 real world data sets; it is observed that GAFCD outperforms the other algorithms in terms of finding max-modularity communities. Furthermore, GAFCD is able to find both fuzzy partitions and crisp partitions while MSFCM can only find fuzzy partitions and GALS can only find crisp partitions. This unique feature makes GAFCD the first genetic algorithm for finding truly fuzzy (i.e., inclusive of both fuzzy and crisp communities) max-modularity community structure in a network.

8:30AM *A Minimax Model of Portfolio Optimization Using Data Mining to Predict Interval Return Rate [#F-14248]*

Meng Yuan and Junzo Watada, Waseda University, Japan

In 1950s, Markowitzs first proposed portfolio theory based on a mean-variance (MV) model to balance the risk and profit of decentral- ized investment. The two main inputs of MV are expected return rate and the variance of expected return rate. The expected return rate is an esti- mated

value which is often decided by experts. Various uncertainty of stock price brings difficulties to predict return rate even for experts. MV model has its tendency to maximize the influence of errors in the input assumptions. Some scholars used fuzzy intervals to describe the return rate. However, there were still some variables decided by experts. This paper proposes a classification method to find the latent relationship between the interval return rate and the trading data of a stock and predict the interval of return rate without consulting any expertise. Then this paper constructs the portfolio model based on minimax rule with interval numbers. The evaluation results show that the proposed method is reliable.

8:50AM *Modeling Time Series with Fuzzy Cognitive Maps [#F-14293]*
Homenda Wladyslaw, Jastrzebska Agnieszka and Pedrycz Witold, Warsaw University Technology, Poland; Systems Research Institute, Polish Academy of Sciences, Poland

Fuzzy Cognitive Maps are recognized knowledge modeling tool. FCMs are visualized with directed graphs. Nodes represent information, edges represent relations within information. The core element of each Fuzzy Cognitive Map is weights matrix, which contains evaluations of connections between map's nodes. Typically, weights matrix is constructed by experts. Fuzzy Cognitive Map can be also reconstructed in an unmanned mode. In this article authors present their own, new approach to time series modeling with Fuzzy Cognitive Maps. Developed methodology joins Fuzzy Cognitive Map reconstruction procedure with moving window approach to time series prediction. Authors train Fuzzy Cognitive Maps to model and forecast time series. The size of the map corresponds to the moving window size and it informs about the length of historical data, which produces time series model. Developed procedure is illustrated with a series of experiments on three real-life time series. Obtained results are compared with other approaches to time series modeling. The most important contribution of this paper is description of the methodology for time series modeling with Fuzzy Cognitive Maps and moving windows.

9:10AM *Possibilistic Projected Categorical Clustering via Cluster Cores [#F-14357]*
Stephen G. Matthews and Trevor P. Martin, University of Bristol, United Kingdom

Projected clustering discovers clusters in subsets of locally relevant attributes. There is uncertainty and imprecision about how groups of categorical values are learnt from data for projected clustering and also the data itself. A method is presented for learning discrete possibility distributions of categorical values from data for projected clustering in order to model uncertainty and imprecision. Empirical results show that fewer, more accurate, more compact, and new clusters can be discovered by using possibility distributions of categorical values when compared to an existing method based on Boolean memberships. This potentially allows for new relationships to be identified from data.

9:30AM *Universal Fuzzy Clustering Model [#F-14374]*
Mika Sato-Ilic, University of Tsukuba, Japan

A universal fuzzy clustering model is proposed in order to adapt to the variability of a similarity data structure. For the purpose of the consideration of the variability of a similarity data, a nonlinear fuzzy clustering model has been proposed. In the nonlinear fuzzy clustering model, the similarity is represented by common degree of membership of a pair of objects to ``each'' fuzzy cluster and an ordinary aggregation operator is used for adjusting variety of the common degree of membership of a pair of objects to ``each'' fuzzy cluster. However, the ordinary aggregation operator is a binary operator and can only adjust for variety of common degree of membership of a pair of objects to ``each'' fuzzy cluster, it cannot adapt the variety of common degree of membership of a pair of objects to ``all'' fuzzy clusters. That is, this model cannot satisfactorily adjust to the variability of the obtained similarity data structure. Therefore, we define a new aggregation operator called a generalized aggregation operator in a linear product space spanned by ``all'' fuzzy clusters and propose a universal fuzzy clustering model based on this generalized aggregation operator in order to adjust to the variability of the obtained similarity data structure.

9:50AM *Iterative Mixed Integer Programming Model for Fuzzy Rule-Based Classification Systems [#F-14449]*
Shahab Derhami and Alice E. Smith, Auburn University, United States

Fuzzy rule based systems have been successfully applied to the pattern classification problem. In this research, we proposed an iterative mixed-integer programming algorithm to generate fuzzy rules for fuzzy rule-based classification systems. The proposed model is capable of assigning the attributes to the antecedents of rules so that their inclusion enhances the accuracy and coverage of that rule. To generate several diverse rules per class, the integer programming model is run iteratively and all samples predicted correctly are temporarily removed from the training dataset in each iteration. This process ensures that subsequent rule covers new samples in the associated class. The proposed model was evaluated on the benchmark datasets from the UCI repository and this comparative study verifies that this approach extracts accurate rules and has advantage over conventional approaches for high dimensional datasets.

10:10AM *Kernel Non-Local Shadowed C-Means for Image Segmentation [#F-14364]*
Long Chen, Jing Zou and C. L. Philip Chen, University of Macau, China

In order to apply successfully the fuzzy clustering algorithms like shadowed C-means (SCM) to image segmentation problems, the spatial information related with each pixel in the image should be carefully calculated and appended to the clustering algorithms. In this paper, the non-local spatial information calculation is introduced to SCM. Because the data in the kernel space demonstrate more linearly-separable shape and the distances calculated in it shows the property of robust to noise and outliers, the proposed clustering algorithm is conducted in the kernel space (aka feature space) mapped from the original space by some implicit mapping functions defined in the kernel functions. Simulations results on some noise images and the comparison with traditional methods demonstrate the efficiency and superiority of the proposed new approach.

Friday, July 11, 10:30AM-12:30PM

Special Session: FrF2-1 Recent Advances in Fuzzy-Model-Based Control Design and Analysis I

Friday, July 11, 10:30AM-12:30PM, Room: 201A, Chair: Hak-Keung Lam

10:30AM *Stability Region Analysis for Polynomial Fuzzy Systems by Polynomial Lyapunov Functions [#F-14014]*

Ying-Jen Chen, Motoyasu Tanaka, Kazuo Tanaka and H. O. Wang, University of Electro-Communications, Japan; Boston University, United States

This paper presents a sum-of-squares (SOS) based methodology to obtain inner bounds on the region-of-attraction (ROA) for nonlinear systems represented by polynomial fuzzy systems. The methodology searches a polynomial Lyapunov function to guarantee the local stability and the invariant subset of the ROA is presented as the level set of the polynomial Lyapunov function. At first the methodology checks whether the considered system can be guaranteed to be locally asymptotically stable. After confirming that the system is guaranteed to be locally asymptotically stable, the methodology enlarges the invariant subset of the ROA as much as possible. The constraints for both of checking stability and enlarging contractively invariant set are represented in terms of bilinear SOS optimization problems. The path-following method is applied to solve the bilinear SOS optimization problems in the methodology.

10:50AM *Dissipativity Analysis for Discrete-Time T-S Fuzzy Systems with Time-Varying Delay and Stochastic Perturbation [#F-14023]*

Xiaozhan Yang, Zhong Zheng, Yuxin Zhao and Ligang Wu, Harbin Institute of Technology, China; Harbin Engineering University, China

This paper addresses the problems of dissipativity analysis for discrete-time Takagi-Sugeno (T-S) fuzzy systems with time-varying state delay and stochastic perturbation. Firstly, the uncertainty of state delay is pulled out of the original system by a novel model transformation process. Consequently the transformed model, which consists of a linear time-invariant system and a norm-bounded uncertain subsystem, is obtained to simplify the dissipativity analysis. By using this model transformation method combined with the Lyapunov-Krasovskii technique, sufficient conditions of the dissipativity are established. Finally, two examples are presented: one shows the effectiveness of model transformation method, and the other presents comparisons with alternative approaches.

11:10AM *A Comparison between T-S Fuzzy Systems and Affine T-S Fuzzy Systems as Nonlinear Control System Models [#F-14491]*

Xiao-Jun Zeng, University of Manchester, United Kingdom

In model based fuzzy control, almost all considered control system models are T- S and affine T-S fuzzy control systems. However, there is a lack of systematic and theoretic understanding what the similarity and difference between these two dominated fuzzy control systems models to provide the guidance to choose the right models to the right application problems. To fill in such a gap, this paper gives a systematic comparison between T-S and affine T-S fuzzy control systems. The main results obtained are, firstly, the similarity between T-S and affine T-S fuzzy control systems is that both can and can only approximate affine nonlinear models and have the similar representation capability for smooth (continuous differentiable) nonlinear control systems. As a result, T-S fuzzy systems are better choice as the stabilization analysis and control design simpler; Secondly, one of the main dissimilarities is that affine T-S fuzzy systems have better representation for continuous only (i.e., not differentiable) nonlinear control systems and can accurately approximate some continuous only nonlinear systems which can not be accurately represented by T-S fuzzy systems. Another main dissimilarity is that affine T-S fuzzy systems are more accurate when representing high dimensional nonlinear systems. As a result, affine T-S fuzzy systems often could be the better choice for non-smooth or high dimensional nonlinear control systems.

11:30AM *Relaxed Stability Conditions Based on Taylor Series Membership Functions for Polynomial Fuzzy-Model-Based Control Systems [#F-14055]*

Chuang Liu, Hak-Keung Lam, Xian Zhang, Hongyi Li and Sai-Ho Ling, King's College London, United Kingdom; Heilongjiang University, China; Bohai University, China; University of Technology, Australia

In this paper, we investigate the stability of polynomial fuzzy-model-based (PFMB) control systems, aiming to relax stability conditions by considering the information of membership functions. To facilitate the stability analysis, we propose a general form of approximated membership functions, which is implemented by Taylor series expansion. Taylor series membership functions (TSMF) can be brought into stability conditions such that the relation between membership grades and system states is expressed. To further reduce the conservativeness, different types of information are taken into account: the boundary of membership functions, the property of membership functions, and the boundary of operating domain. Stability conditions are obtained from Lyapunov stability theory by sum of squares (SOS) approach. Simulation examples demonstrate the effect of each piece of information.

11:50AM *Faults Diagnosis Based on Proportional Integral Observer for TS Fuzzy Model with Unmeasurable Decision Variable [#F-14117]*

T. Youssef, H. R. Karimi and M. Chadli, Mohamed Bougara University of Boumerdes, Algeria; University of Agder, Norway; University of Picardie Jules Verne, France

In this work, we focus on the synthesis of a Proportional Integral (PI) observer for the actuators and sensors faults diagnosis based on Takagi-Sugeno (TS) fuzzy model with unmeasurable decision variables. The faults estimation method is based on the assumption that these unknown inputs are in polynomials form whose their kth derivatives are bounded. The convergence conditions of the observer as well as the faults reconstruction are established on the basis of the Lyapunov stability theory and the L2 optimization technique, expressed as Linear Matrix Inequalities (LMI) constraints. In order to validate the proposed approach, a hydraulic system with two tanks is proposed.

12:10PM *Dynamic Output Feedback Controller Design for T-S Fuzzy Plants with Actuator Saturation Using Linear Fractional Transformation [#F-14140]*

Yang Liu, Xiaojun Ban, Fen Wu and Hak-Keung Lam, Harbin Institute of Technology, China; North Carolina State University, United States; King's College London, United Kingdom

In this paper, a systematic synthesis method for Takagi-Sugeno fuzzy dynamic output feedback controller is proposed for T-S fuzzy plants with actuator saturation. By using the deadzone function, both the T-S fuzzy plant with actuator saturation and the T-S fuzzy dynamic output feedback controller are transformed into the form of linear fractional transformation (LFT). Within the framework of LFT, the issue of stability as well as H_infinity performance is cast as a convex optimization problem which can be approached by solving a set of linear matrix inequalities. A numerical example is presented to illustrate the effectiveness of the proposed method.

Special Session: FrF2-2 Software for Soft Computing I

Friday, July 11, 10:30AM-12:30PM, Room: 201B, Chair: Jesus Alcala-Fdez

10:30AM *Supervising Classrooms Comprising Children with Dyslexia and Other Learning Problems with Graphical Exploratory Analysis for Fuzzy Data: Presentation of the Software Tool and Case Study [#F-14273]*

Ana Palacios and Luciano Sanchez, Universidad de Granada, Spain; Universidad de Oviedo, Spain

A case study is presented where a classroom comprising children with dyslexia and other learning problems is monitored with a proprietary software tool. This tool implements graphical exploratory analysis for fuzzy data, has classification and prediction capabilities, and outputs a compared visualization of the results of the tests applied to the children in the classroom and their expected evolution in the near future. The software also helps to detect different groups in the class, and could recommend professional treatment in case that some indicators were deemed abnormal. Data can be introduced without the help of a pshychologist thus visualization and diagnostic tasks can be performed by parents and teachers on their own.

10:50AM *The Experimenter Environment of the NIP Imperfection Processor [#F-14193]*

Raquel Martinez, Jose M. Cadenas and M. Carmen Garrido, University of Murcia, Spain

Currently, most datasets from real-world problems contain low-quality data. In particular, within soft computing and data mining areas, the research and development of techniques that can deal with this type of data has been increased recently. In order to facilitate the design of experiments in this field and with these data, an experimenter environment in NIP imperfection processor software tool has been developed. This environment allows the generation of datasets with low-quality data, allowing the researcher to design experiments that analyze the robustness of different techniques which utilize this type of information in an easy and intuitive way.

11:10AM *Learning from Data Using the R Package frbs [#F-14188]*

Lala Septem Riza, Christoph Bergmeir, Francisco Herrera and Jose Manuel Benitez, University of Granada, Spain

Learning from data is a process to construct a model according to available training data so that it can be used to make predictions for new data. Nowadays, several software libraries are available to carry out this task. frbs is an R package which is aimed to construct models from data based on fuzzy rule based systems (FRBSs) by employing learning procedures from Computational Intelligence (e.g., neural networks and genetic algorithms) to tackle classification and regression problems. For the learning process, frbs considers well-known methods, such as Wang and Mendel's technique, ANFIS, HyFIS, DENFIS, subtractive clustering, SLAVE, and several others. Many options are available to perform conjunction, disjunction, and implication operators, defuzzification methods and membership functions (e.g. triangle, trapezoid, Gaussian, etc). It has been developed in the R language which is an open-source analysis environment for scientific computing. In this paper, we also provide some examples on the usage of the package and a comparison with other software libraries implementing FRBSs. We conclude that frbs should be considered as an alternative software library for learning from data.

11:30AM *Parallel Mining of Fuzzy Association Rules on Dense Data Sets [#F-14382]*

Michal Burda, Viktor Pavliska and Radek Valasek, University of Ostrava, Czech Republic

The aim of this paper is to present a scalable parallel algorithm for fuzzy association rules mining that is suitable for dense data sets. Unlike most of other approaches, we have based the algorithm on the Webb's OPUS search algorithm. Having adopted the master/slave architecture, we propose a simple recursion threshold technique to allow load-balancing for high scalability.

11:50AM *Designing a Compact Genetic Fuzzy Rule-Based System for One-Class Classification [#F-14516]*

Pedro Villar, Bartosz Krawczyk, Ana M. Sanchez, Rosana Montes and Francisco Herrera, University of Granada, Spain; Wroclaw University of Technology, Poland

This paper proposes a method for designing Fuzzy Rule-Based Classification Systems to deal with One-Class Classification, where during the training phase we have access only to objects originating from a single class. However, the trained model must be prepared to deal with new, unseen adversarial objects, known as outliers. We use a Genetic Algorithm for learning the granularity, domains and fuzzy partitions of the model and we propose an ad-hoc rule generation method specific for One-Class Classification. Several datasets from UCI repository, previously transformed to one-class problems, are used in the experiments and we compare with two of the classical methods used in the One-Class community, one-class Support Vector Machines and Support Vector Data Description. Our proposal of fuzzy model obtains similar results than the other methods but presents a high interpretability due its reduced number of rules.

12:10PM *A Method for Hybrid Personalized Recommender Based on Clustering of Fuzzy User Profiles [#F-14244]*

Shan Xu and Junzo Watada, Waseda University, Japan

Personalized Recommenders can help to find potential items and then recommend them for particular users. Conventional recommender methods always work on a rating schema that items are rated from 1 to 5. However, there are several rating schemas (ways that items are rated) in reality, which are overlooked by conventional methods. By transforming rating schemas into fuzzy user profiles to record users' preferences, our proposed method can deal with different system rating schemas, and improve the scalability of recommender systems. Additionally, we incorporate user-based method with item-based collaborative methods by clustering users, which can help us to gain insight into the relationship between users. The aim of this research is to provide a new method for personalized recommendation. Our proposed method is the first to normalize the user vectors using fuzzy set theory before the k-medians clustering method is adjusted, and then to apply item- based collaborative algorithm with item vectors. To evaluate the effectiveness of our approach, the proposed algorithm is compared with two conventional collaborative filtering methods, based on MovieLens data set. As expected, our proposed method outperforms the conventional collaborative filtering methods as it can improve system scalability while maintaining accuracy.

Special Session: FrF2-3 Fuzzy Interpolation

Friday, July 11, 10:30AM-12:30PM, Room: 201C, Chair: Qiang Shen and Laszlo Koczy

10:30AM *A New Interval-Based Method for Handling Non-Monotonic Information [#F-14065]*

Yi Wen Kerk, Kai Meng Tay and Chee Peng Lim, Universiti Malaysia Sarawak, Malaysia; Deakin University, Australia

The focus of this paper is on handling non-monotone information in the modelling process of a single-input target monotone system. On one hand, the monotonicity property is a piece of useful prior (or additional) information which can be exploited for modelling of a monotone target system. On the other hand, it is difficult to model a monotone system if the available information is not monotonically-ordered. In this paper, an interval-based method for analysing non-monotonically ordered information is proposed. The applicability of the proposed method to handling a non-monotone function, a non-monotone data set, and an incomplete and/or non-monotone fuzzy rule base is presented. The upper and lower bounds of the interval are firstly defined. The region governed by the interval is explained as a coverage measure. The coverage size represents uncertainty pertaining to the available information. The proposed approach constitutes a new method to transform non-monotonic information to interval- valued monotone system. The proposed interval-based method to handle an incomplete and/or non-monotone fuzzy rule base constitutes a new fuzzy reasoning approach.

10:50AM *Closed Form Fuzzy Interpolation with Interval Type-2 Fuzzy Sets [#F-14179]*

Longzhi Yang, Chengyuan Chen, Nanlin Jin, Xin Fu and Qiang Shen, Northumbria University, United Kingdom; Aberystwyth University, United Kingdom; Xiamen University, China

Fuzzy rule interpolation enables fuzzy inference with sparse rule bases by interpolating inference results, and may help to reduce system complexity by removing similar (often redundant) neighbouring rules. In particular, the recently proposed closed form fuzzy interpolation offers a unique approach which guarantees convex interpolated results in a closed form. However, the difficulty in defining the required precise-valued membership functions still poses significant restrictions over the applicability of this approach. Such limitations can be alleviated by employing type-2 fuzzy sets as their membership functions are themselves fuzzy. This paper extends the closed form fuzzy rule interpolation using interval type-2 fuzzy sets. In this way, as illustrated in the experiments, closed form fuzzy interpolation is able to deal with uncertainty in data and knowledge with more flexibility.

11:10AM *Building Fuzzy Inference Systems with Similarity Reasoning: NSGA II-Based Fuzzy Rule Selection and Evidential Functions [#F-14319]*

Tze Ling Jee, Kok Chin Chai, Kai Meng Tay and Chee Peng Lim, Universiti Malaysia Sarawak, Malaysia; Deakin University, Australia

In our previous investigations, two Similarity Reasoning (SR)-based frameworks for tackling real-world problems have been proposed. In both frameworks, SR is used to deduce unknown fuzzy rules based on similarity of the given and unknown fuzzy rules for building a Fuzzy Inference System (FIS). In this paper, we further extend our previous findings by developing (1) a multi-objective evolutionary model for fuzzy rule selection; and (2) an evidential function to facilitate the use of both frameworks. The Non-Dominated Sorting Genetic Algorithms-II (NSGA-II) is adopted for fuzzy rule selection, in accordance with the Pareto optimal criterion. Besides that, two new evidential functions are developed, whereby given fuzzy rules are considered as evidence. Simulated and benchmark examples are included to demonstrate the applicability of these suggestions. Positive results were obtained.

11:30AM *Genetic Algorithm-Aided Dynamic Fuzzy Rule Interpolation [#F-14440]*

Nitin Naik, Ren Diao and Qiang Shen, Aberystwyth University, United Kingdom

Fuzzy rule interpolation (FRI) is a well established area for reducing the complexity of fuzzy models and for making inference possible in sparse rule-based systems. Regardless of the actual FRI approach employed, the interpolative reasoning process generally produces a large number of interpolated rules, which are then discarded as soon as the required outcomes have been obtained. However, these interpolated rules may contain potentially useful information, e.g., covering regions that were uncovered by the original sparse rule base. Thus, such rules should be exploited in order to develop a dynamic rule base for improving the overall system coverage and efficacy. This paper presents a genetic algorithm based dynamic fuzzy rule interpolation framework, for the purpose of selecting, combining, and promoting informative, frequently used intermediate rules into the existing rule base. Simulations are employed to demonstrate the proposed method, showing better accuracy and robustness than that achievable through conventional FRI that uses just the original sparse rule base.

11:50AM *Antecedent Selection in Fuzzy Rule Interpolation Using Feature Selection Techniques [#F-14443]*

Ren Diao, Shangzhu Jin and Qiang Shen, Aberystwyth University, United Kingdom

Fuzzy rule interpolation offers a useful means for enhancing the robustness of fuzzy models by making inference possible in systems of only a sparse rule base. However in practical applications, the rule bases provided may contain irrelevant, redundant, or even misleading antecedents, which makes the already challenging tasks such as inference and interpolation even more difficult. The majority of the techniques developed in the literature assumes equal significance of rules and their antecedents, which may lead to biased or incorrect reasoning outcomes. This paper investigates similar problems being tackled in the area of feature selection, in an attempt to identify techniques that can be applied to measure the significance of rule antecedents. In particular, two feature evaluation methods based on correlation analysis and fuzzy-rough set theory have been examined, in order to reveal their effectiveness in determining the importance of individual antecedents, and their capabilities for discovering subsets of antecedents that provide similar reasoning accuracies as a larger set of antecedents used in the original rules. In addition, the significance values measured by the proposed method are treated as the weights associated with the relevant rule antecedents, in an effort to facilitate more appropriate selection of, and interactions with the rules in performing both forward and backward fuzzy rule interpolation via scale and move transformation-based methods. Experimental studies based on a practical scenario concerning terrorist activities and also synthetic random data are conducted, demonstrating the potential and efficacy of the proposed work.

12:10PM *Fuzzy Rule Interpolation Based Fuzzy Signature Structure in Building Condition Evaluation [#F-14535]*

Gergely Molnarka, Szilveszter Kovacs and Laszlo Koczy, Szechenyi Istvan University, Hungary; University of Miskolc, Hungary

The complexity of the residential house structures makes their condition evaluation difficult. Taking the human experts' thinking into consideration the linguistic approach seems reasonable, therefore the fuzzy set theory may provide a basis for creating an expert system. In practice, the assessment of some predefined attributes of building components may give a comprehensive value about the condition of the examined building on a relative scale. The data structure of building evaluation procedure makes clear that the fuzzy signature structure is helpful in analysis. The numerous building components that determine the character of the given building can turn to an unnecessarily large rule-base. The fuzzy rule interpolation and the

corresponding sparse fuzzy rule- based knowledge representation could be a reasonably efficient structure for handling the building evaluation procedure. In this paper the fuzzy rule interpolation as a novel aggregation method in fuzzy signature structures is proposed. Its application is presented with a case study of roof structure evaluation of a classic urban-type residential house located in a historic district of Budapest, Hungary.

FrF2-4 Fuzzy Decision Making and Decision Support Systems II

Friday, July 11, 10:30AM-12:30PM, Room: 201D, Chair: Vladik Kreinovich and Toshihiko Watanabe

10:30AM *Multiple Attribute Group Decision Making Using Interval-Valued Intuitionistic Fuzzy Soft Matrix [#F-14240]*

Sujit Das, Mohuya B. Kar, Tandra Pal and Samarjit Kar, National Institute of Technology, India; Heritage Institute of Technology, India

A noticeable progress has been found in decision making problems since the introduction of soft set theory by Molodtsov in 1999. It is found that classical soft sets are not suitable to deal with imprecise parameters whereas fuzzy soft sets (FSS) are proved to be useful. Use of intuitionistic fuzzy soft sets (IFSS) is more effective in environment, where arguments are presented using membership and nonmembership values. In this paper we propose an algorithmic approach for multiple attribute group decision making problems using interval-valued intuitionistic fuzzy soft matrix (IVIFSM). IVIFSM is the matrix representation of intervalvalued intuitionistic fuzzy soft set (IVIFSS), where IVIFSS is a natural combination of interval-valued intuitionistic fuzzy set and soft set theory. Firstly, we propose the concept of IVIFSM. Then an algorithm is developed to find out the desired alternative(s) based on product interval-valued intuitionistic fuzzy soft matrix, combined choice matrix, and score values of the set of alternatives. Finally, a practical example has been demonstrated to show the effectiveness of the proposed algorithm.

10:50AM *Towards Data-Driven Environmental Planning and Policy Design -Leveraging Fuzzy Logic to Operationalize a Planning Framework [#F-14385]*

Amir Pourabdollah, Christian Wagner, Simon Miller, Michael Smith and Ken Wallace, The University of Nottingham, United Kingdom; Department of Parks and Wildlife, Australia

Environmental planning is complex, and requires careful consideration of a large number of factors, including quantitative ones (e.g., water balance) and qualitative ones (e.g., heterogeneous stakeholder input). To better integrate these factors, value-driven frameworks have been designed in the environmental conservation community. These frameworks are currently largely utilized manually by conservation and policy experts in order to inform policy design. In this paper, we present a fuzzy logic based system, which has been developed to operationalize the existing manual framework while preserving essential qualities, including the capture of uncertainty in the data sources and a consistent interpretability of the underlying automatic reasoning mechanisms. We provide a detailed description of the current implementation which can be applied in the operationalization of policy design and planning tasks in a range of natural resources management cases, followed by a set of concrete, practical outputs for a studied use case in Western Australia. Finally, we highlight remaining limitations and future work.

11:10AM *A New Fuzzy Approach for Multi-Source Decision Fusion [#F-14436]*

Farnoosh Fatemipour, Mohammad-R Akbarzadeh-T and Rouhollah Ghasempour, Ferdowsi University of Mashhad, Iran

Nowadays, we are facing the rapidly growing amount of data being produced in many organizations, social networks and internet. These data are generated in disparate locations and their aggregation into one location is exceedingly time and space consuming. Traditional statistical methods are not sufficient for processing of this massive multi-source data. In this paper, we propose a new fuzzy-based decision fusion approach for classification problems of this kind. The necessity of fuzzy information arises in distributed classification because imprecision, uncertainty and ambiguity can be found at all information sources, from the data itself to the results of the classifiers. In the proposed approach, multiple classifiers are constructed based on different information sources which have different degrees of reliability. Then a fuzzy rule based system is designed for approximating distribution of reliabilities of sources over the input space. The decision fusion of multiple classifiers takes place using the estimated degrees of sources' reliabilities. Comparison results are made between both centralized classification and two other distributed classification methods. One is averaging and the other is discounting each classifier's decision based on its accuracy. Results show the high accuracy of the proposed method in making decisions in distributed environments, without the overhead of aggregating the entire data in one location.

11:30AM *Towards Decision Making under Interval, Set-Valued, Fuzzy, and Z-Number Uncertainty: A Fair Price Approach [#F-14454]*

Joe Lorkowski, Rafik Aliev and Vladik Kreinovich, University of Texas at El Paso, United States; Azerbaijan State Oil Academy, Azerbaijan

In this paper, we explore one of the possible ways to make decisions under uncertainty: namely, we explain how to define a fair price for a participation in such a decision, and then select an alternative for which the corresponding fair price is the largest. This idea is explained on the examples of interval uncertainty, set-valued, fuzzy, and Z-number uncertainty.

11:50AM *A Fuzzy-Logic-Based Approach for Soft Data Constrained Multiple-Model PHD Filter [#F-14476]*

Sepideh Seifzadeh, Bahador Khaleghi and Fakhri Karray, University of Waterloo, Canada

Tracking multiple targets with non-linear dynamics is a challenging problem. One of the popular solutions, Sequential Monte Carlo-Probability Hypothesis Density (SMC-PHD) filter, deploys a Random Set (RS) theoretic formulation along with the Sequential Monte Carlo approximation, which is a variant of Bayes filtering. The performance of Bayesian filtering-based methods can be enhanced by using extra information incorporated as specific constraints into the filtering process. Following the same principle, this paper proposes a constrained variant of the SMC-PHD filter, in which the inherently vague human-generated data are transformed into a set of constraints using a fuzzy logic approach. These constraints are enforced to the filtering process by applying coefficients to the particles' weights. The Soft Data (SD) reports on target agility level; wherein, the agility refers to the case in which the observed dynamics of the targets deviates from its given probabilistic characterization. Consequently, the proposed constrained filtering approach enables dealing with multitarget tracking scenarios in presence of target agility, as demonstrated by the experimental results presented in this paper.

12:10PM *Handling Preferences Under Uncertainty in Recommender Systems [#F-14450]*

Samia Boulkrinat, Allel Hadjali and Aicha Aissani-Mokhtari, RIIMA/USTHB University, Algeria; LIAS/ENSMA, France

While uncertainty can't be ignored in real-world problems, there is almost no research work addressing this issue in the recommender systems framework, especially all that relates to user ratings preferences. Indeed, the subjectivity of user's rating and his/her changing preferences over time, make them

subject to uncertainty. Usually, user's imprecise rating for an item (product or service) is time-dependent information and generally provided much later. Meantime the item may change either by degrading or improving its inherent quality. The rating therefore may deviate, since it doesn't describe faithfully the actual current state of the item. This deviation leads to a form of uncertainty on user preferences that we handle in this paper. We show that uncertainty is an ubiquitous aspect in building recommender systems and its taking into account can help predicting the most accurate items by improving their certainty degrees.

12:30PM *Flexible Decision Support System Using Dynamic Partial Reconfiguration Technology [#F-14484]*

Janos Grantner and Chinh Nguyen, Western Michigan University, United States; Western Michigan University, Viet Nam

Intelligent decision support systems may be required to adapt to changes in their operating environment. FPGA-based hardware accelerators can be used to design embedded systems that are reprogrammable and reconfigurable. Partial reconfiguration allows that some regions of the FPGA be dynamically reconfigured while other tasks are still running in the remainder of the device. A hardware accelerator was developed for a fuzzy automaton-based decision support system in the context of testing eye-hand coordination skills for handicapped children. A Zynq-7000 FPGA platform was used for this research. Matlab simulations and a test bench environment were designed to verify the results of the hardware simulations and implementation.

Friday, July 11, 1:30PM-3:30PM

Special Session: FrF3-1 Recent Advances in Fuzzy-Model-Based Control Design and Analysis II

Friday, July 11, 1:30PM-3:30PM, Room: 201A, Chair: Hak-Keung Lam

1:30PM *Discrete-Time Takagi-Sugeno Descriptor Models: Controller Design [#F-14147]*

Victor Estrada-Manzo, Thierry Marie Guerra, Zsofia Lendek and Philippe Pudlo, University of Valenciennes and Hainaut-Cambresis, France; The Technical University of Cluj-Napoca, Romania

Many physical systems are naturally represented by descriptor models. This paper is concerned with stabilization of discrete-time descriptor systems represented by Takagi-Sugeno fuzzy models. Two different approaches are presented based on non- quadratic Lyapunov functions. The results are expressed in terms of linear matrix inequalities. Numerical examples validate the proposed methods.

1:50PM *Observer Design for Switching Nonlinear Systems [#F-14152]*

Zsofia Lendek, Paula Raica, Jimmy Lauber and Thierry-Marie Guerra, Technical University of Cluj-Napoca, Romania; Universite de Valenciennes et du Hainaut-Cambresis, France

In this paper we consider observer design for discrete-time switching systems represented by Takagi-Sugeno fuzzy models. For the design we use a switching Lyapunov function defined on the switches. In order to develop stability conditions for the estimation error dynamics, we consider the variation of this function along possible switches. The conservativeness of the approach is reduced by considering the alpha-sample variation of the Lyapunov function. This approach can bring solutions to observer design for some switching systems with unobservable and unstable local models. The developed conditions are illustrated on a numerical example.

2:10PM *Model Predictive Control for Discrete Fuzzy Systems via Iterative Quadratic Programming [#F-14167]*

Carlos Arino, Emilio Perez, Antonio Sala and Andres Querol, Universitat Jaume I, Spain; Univesidad Politecnica de Valencia, Spain

TS fuzzy models are exact representations of nonlinear systems in a compact region. Guaranteed-cost LMIs produce controllers which minimize a shape- independent bound on a quadratic cost; however, the controller has a fixed structure (possibly suboptimal), say PDC, and does not allow input saturation. By posing the problem as a Model Predictive Control one, the ideas of terminal set, terminal controller and feasible set can be used in order to improve the performance of usual guaranteed-cost controllers for TS systems via Quadratic Programming. A Polya-based approach has been introduced in order to (conservatively) transform the invariant set problem into a polytopic one, as well as computing the controller feasibility region. The optimal controller is computed iteratively.

2:30PM *A Novel Relaxed Stabilization Condition for a Class of T-S Time-Delay Fuzzy Systems [#F-14171]*

Shun-Hung Tsai and Cone-Jie Fang, National Taipei University of Technology, Taiwan

In this paper, the relaxed delay-dependent stabiliza- tion problem for a class of Takagi and Sugeno (T-S) fuzzy time- delay systems is explored. By utilizing homogeneous polynomials scheme, P'olya's theorem and some slack matrices, a novel relaxed stabilization condition for a class of T-S fuzzy time-delay systems is proposed in terms of a linear matrix inequalities (LMIs). Finally, an example is given to demonstrate that the proposed stabilization condition can provide a longer allowable delay time than some existing studies.

2:50PM *SOS-Based Fuzzy Stability Analysis via Homogeneous Lyapunov Functions [#F-14190]*

Ji-Chang Lo, National Central University, Taiwan

The class of polynomial fuzzy-model-based (PFMB) control systems has gained considerable attention in fuzzy control. The PFMB control system under consideration often assumes that the Lyapunov functions are quadratic, allowing use of semidefinite programming and the sum of squares decomposition. This paper introduces a homogeneously polynomial Lyapunov function for a stabilization problem in which the state feedback synthesis based on SOS decomposition is proposed. To verify the analytical theories regarding PFMB stabilization with the proposed method, two examples are demonstrated to show the effectiveness of the proposed approach.

3:10PM *Fuzzy Disturbance Observer for a Class of Polynomial Fuzzy Control Systems [#F-14200]*

Hugang Han, Yuta Higaki and Hak-Keung Lam, Prefectural University of Hiroshima, Japan; King's College London, United Kingdom

Disturbance observer-based control provides a promising approach to handle system disturbance and improve robustness. In this paper, a new fuzzy disturbance observer (FDO) is proposed into the SOS- based approach, where the polynomial fuzzy model is used to develop the system controller. Compared with other works published so far, the FDO mainly features two things: 1) the estimation error between the FDO and disturbance shrinks asymptotically to zero if the disturbance has a constant steady-state value; 2) parameters involved in the FDO is adjusted on the basis of the polynomial fuzzy model which is basically nonlinear. Finally, computer simulations are provided to illustrate the effectiveness of the proposed approach.

Special Session: FrF3-2 Software for Soft Computing II

Friday, July 11, 1:30PM-3:30PM, Room: 201B, Chair: Jesus Alcala-Fdez

1:30PM *Jfcs Tool: A Java Software Tool to Design Fuzzy Color Spaces [#F-14274]*

Jose Manuel Soto-Hidalgo, Jesus Chamorro-Martinez, P. Martinez-Jimenez and D. Sanchez, University of Cordoba, Spain; University of Granada, Spain

This paper introduces a software tool for designing customized fuzzy color spaces able to fill the semantic gap between the color representation in computers and the subjective human perception. Fuzzy colors allow introducing semantics in the description of color by using linguistic labels, taking into account the fuzzy boundaries between the representation of color terms. JFCS Tool is based on an approach, proposed by the authors in previous works, for developing fuzzy color spaces on the basis of a collection of color names and corresponding color crisp representatives. The software is implemented in Java and includes several graphical tools to build fuzzy color spaces, allowing to obtain membership degrees of pixels taken from images to each fuzzy color in a certain fuzzy color space.

1:50PM *JuzzyOnline: An Online Toolkit for the Design, Implementation, Execution and Sharing of Type-1 and Type-2 Fuzzy Logic Systems [#F-14044]*

Christian Wagner, Mathieu Pierfitte and Josie McCulloch, University of Nottingham, United Kingdom; Institut National Polytechnique de Toulouse, France

In this paper we present an online fuzzy logic toolkit for the design, implementation, execution and sharing of type-1 (T1), interval type-2 (T2) and (zSlices based) general T2 fuzzy logic system (FLSs). The motivation to develop the toolkit stems from the desire to provide a free-to-use fuzzy logic toolkit available which is platform-independent, easily accessible and which does not require any background knowledge of programming. This toolkit aims to help expand the accessibility of FLSs, in particular of T2 FLSs, to both research and industrial applications outside of the fuzzy logic community and computer science more generally. We review the features currently available through the JuzzyOnline toolkit (including a complete, previously unseen visualisation of the inference steps for zSlices based general T2 FLSs) and demonstrate a sample Fuzzy Logic System implementation of the toolkit. Finally, we conclude with some future developments and a call for feedback and contributions to aid in further development.

2:10PM *On Modelling Real-World Knowledge to Get Answers to Fuzzy and Flexible Searches without Human Intervention [#F-14299]*

Victor Pablos-Ceruelo and Susana Munoz-Hernandez, Universidad Politecnica de Madrid, Spain

The Internet has become a place where massive amounts of information and data are being generated every day. This information is most of the times stored in a non-structured way, but the times it is structured in databases it cannot be retrieved by using easy fuzzy queries. Being the information in the database the distance to the city center of some restaurants (and their names) by easy fuzzy queries we mean queries like ``I want a restaurant close to the center''. Since the computer does not have knowledge about the relation between being close to the center and the distance to the center (of a restaurant) it does not know how to answer this query by itself. We need human intervention to tell the computer from which database column it needs to retrieve data (the one with the restaurant's distance to the center), and how this non-fuzzy information is fuzzified (applying the close function to the retrieved value). Once this is done it can give an answer, just ordering the database elements by this new computed attribute. This example is very simple, but there are others not so simple, as ``I want a restaurant close to the center, not very expensive and whose food type is mediterranean''. Doing this for each existing attribute does not seem to be a very good idea. We present a web interface for posing fuzzy and flexible queries and a search engine capable of answering them without human intervention, just from the knowledge modelled by using the framework's syntax. In a nutshell, we can provide this facility thanks to the syntax that our framework offers us for modelling the real-world knowledge we have. We expect this work contributes to the development of more human-oriented fuzzy search engines.

2:30PM *Specialized Software for Fuzzy Natural Logic and Fuzzy Transform Applications [#F-14066]*

Vilem Novak, Viktor Pavliska and Radek Valasek, University of Ostrava, IRAFM, Czech Republic

In this paper, three special soft computing software systems are presented. The systems are based on the original results in two areas: fuzzy natural logic and fuzzy transform. The first software is LFL Controller that is a universal SW system that can be used in fuzzy or linguistic control, and in decision-making. The system implements results of fuzzy natural logic, namely the theory of evaluative linguistic expressions and perception-based logical deduction. This means the the control or decision strategy are defined directly in natural language. Additionally, it can also realize classical fuzzy control on the basis of relational interpretation of fuzzy IF-THEN rules. This system has wide range of applications and was already applied in control of real plants. The second system is LFL Forecaster that is a specialized SW for analysis and forecasting of time series. The analysis is realized using F-transform and forecasting using results of fuzzy natural logic. The third system is FT-Studio that is a specialized SW for computation of fuzzy transform of functions that can be defined either using a formula, or given by data.

2:50PM *A WiFi-Based Software for Indoor Localization [#F-14529]*

Noelia Hernandez, Manuel Ocana, Sergio Humanes, Pedro Revenga, David P. Pancho and Luis Magdalena, University of Alcala, Spain; European Centre For Soft Computing, Spain; European Centre for Soft Computing, Spain

Indoor localization is increasingly required for applications like deployment of rescue teams in emergency situations, proactive care for the elders, and so on. The quick growing of coverage of WiFi networks makes WiFi technology a very promising choice for indoor localization. But, this localization should be linked to a map to be useful. This work presents an open-access software designed for that purpose. It is composed of two different applications, a desktop software for research purposes and an Android application for user friendly localization. We address the localization task as a high dimensional classification problem. So far, we have developed classifiers based on the

classic Nearest Neighbour, Support Vector Machines (SVM) and fuzzy rule-based classifiers. This work is made in the context of the ABSYNTHE project which is aimed at creating human-robot teams. We show a use case of the new software in one of the scenarios of the ABSYNTHE project.

3:10PM *Analyzing Fuzzy Association Rules with Fingrams in KEEL [#F-14514]*

David P. Pancho, Jose M. Alonso, Jesus Alcala-Fdez and Luis Magdalena, European Centre for Soft Computing, Spain; University of Granada, Spain

This work presents the full integration of fuzzy inference-grams (Fingrams) in KEEL to visual analysis of fuzzy association rules. Fingrams graphically represent fuzzy rule-based systems (FRBSs) in 2D graphs that illustrate the interaction among fuzzy rules in terms of rule cofiring, i.e., paying attention to rule pairs simultaneous fired by a given input. The new module allows to generate Fingrams for fuzzy association rules created in the suite KEEL, that can be afterwards analyzed to comprehend the system behavior and improve it. We sketch the use and potentials in an illustrative example built in KEEL over a real-world dataset including qualitative assessments of a set of design chairs.

Special Session: FrF3-3 Theory of Type-2 Fuzzy Systems

Friday, July 11, 1:30PM-3:30PM, Room: 201C, Chair: Bob John, Jon Garibaldi and Simon Coupland

1:30PM *Type-1 or Interval Type-2 Fuzzy Logic Systems - On the Relationship of the Amount of Uncertainty and FOU Size [#F-14112]*

Jabran Aladi, Christian Wagner and Jonathan Garibaldi, University of Nottingham, United Kingdom

A recurring theme in research employing type-2 fuzzy sets is the question of how much uncertainty in a given context warrants the application of type-2 fuzzy sets and systems over their type-1 counterparts. In this paper we provide insight into this challenging question through a detailed investigation into the ability of both types of Fuzzy Logic Systems (FLSs) to capture and model different levels of uncertainty/noise through varying the size of the Footprint Of Uncertainty (FOU) of the underlying fuzzy sets from type-1 fuzzy sets to very "wide" interval type-2 fuzzy sets. By applying the study in the well-controlled context of chaotic time-series prediction, we show how, as uncertainty/noise increases, type-2 FLSs with fuzzy sets with FOUs of increasing size become more and more viable. While the work in this paper is focused on a specific application, we believe it provides crucial insight into the challenging question of the viability of interval type-2 over type-1 FLSs.

1:50PM *Building a Type-2 Fuzzy Regression Model Based on Credibility Theory and Its Application on Arbitrage Pricing Theory [#F-14129]*

Yicheng Wei and Junzo Watada, Waseda University, Japan

Information in real life may have linguistically vagueness. Thus, type-1 fuzzy set was introduced to model this uncertainty. Additionally, same words will mean variously to different people, which means uncertainty also exists when associated with the membership function of a type-1 fuzzy set. Type-2 fuzzy set is then invented to express the hybrid uncertainty of both primary fuzziness and secondary one of membership functions. On the one hand, type-2 fuzzy variable models the vagueness of information better. On the other hand, those variables are hard to deal with its three-dimensional feature given. To address problems in presence of such variables with hybrid fuzziness, a new class of type-2 fuzzy regression model is built based on credibility theory, and is called the T2 fuzzy expected value regression model. The new model will be developed into two forms: form-A and form-B. This paper is a further work based on our former research of type-2 fuzzy qualitative regression model.

2:10PM *Building Linguistic Random Regression Model from the Perspective of Type-2 Fuzzy Set [#F-14199]*

Fei Song, Shinya Imai and Junzo Watada, Waseda University, Japan

Information given in linguistic terms around real life sometimes is vague in meaning, as type-1 fuzzy set was introduced to modulate this uncertainty. Meanwhile, same word may result in various meaning to people, indicating the uncertainty also exist when associated with the membership function of a type-1 fuzzy set. Type-2 fuzzy set attempt to express the hybrid uncertainty of both primary and secondary fuzziness, in order to address regression problems, we built a type-2 Linguistic Random Regression Model based on credibility theory. Confidence intervals are constructed for fuzzy input and output, and the proposed regression model give a rise to a nonlinear programming problem focus on a well- trained model, which would be helpful and useful in linguistic assessment cases. Finally, a numerical example is provided.

2:30PM *Automatic Learning of General Type-2 Fuzzy Logic Systems Using Simulated Annealing [#F-14249]*

Majid Almaraashi, Robert John and Hopgood Adrian, Umm Al- Qura University, Saudi Arabia; University of Nottingham, United Kingdom; Sheffield Hallam University, United Kingdom

This paper reports on a new approach for automatic learning of general type-2 fuzzy logic systems (GT2FLSs) using simulated annealing (SA). The learning process in this work starts without an initial interval type-2 fuzzy system and has an objective to optimize all membership function parameters involved in the general type-2 fuzzy set in two stages. This is a novel methodology for learning GT2FLSs using the vertical-slices representation. The methodology used here is based on a proposed parameterization method presented in a previous work to ease the design of GT2FLSs. Two models of GT2FLSs have been applied using two different type-reduction techniques. The first technique is the sampling method, which is nondeterministic. The second technique is the vertical-slices centroid type-reduction (VSCTR), which is deterministic. Both models as well as an interval type-2 fuzzy logic system (IT2FLS) model have been applied to predict a Mackey-Glass time series. A comparison of the results of modeling these problems using the three models showed more accurate modeling for the GT2FLSs when using the VSCTR deterministic defuzzification method. It has also been shown that a GT2FLS with VSCTR defuzzification is more able to handle uncertainty than an IT2FLS, although the latter was faster. I

2:50PM *A New Monotonic Type-Reducer for Interval Type-2 Fuzzy Sets [#F-14384]*

Simon Coupland, Robert John and Hussam Hamrawi, De Montfort University, United Kingdom; Nottingham University, United Kingdom; University of Bhari, Sudan

This paper presents a new defuzzification algorithm for interval type-2 fuzzy sets. The algorithm exploits the fact that we can treat an interval type-2 fuzzy set as two type-2 fuzzy sets. We suggest in this paper that monotonicity is an important property for defuzzifiers and so we provide a definition of monotonicity for type-2 defuzzifiers based on previous work by Runkler. The research reported here shows that our new operator is monotonic and provides a defuzzified value that lies within the interval computed by the popular Karnik-Mendel algorithm.

3:10PM *A Support Vector-Based Interval Type-2 Fuzzy System [#F-14437]*

Volkan Uslan, Huseyin Seker and Robert John, De Montfort University, United Kingdom; University of Nottingham, United Kingdom

In this paper, a new fuzzy regression model that is supported by support vector regression is presented. Type-2 fuzzy systems are able to tackle applications that have significant uncertainty. However general type-2 fuzzy systems are more complex than type-1 fuzzy systems. Support vector machines are similar to fuzzy systems in that they can also model systems that are non-linear in nature. In the proposed model the consequent parameters of type-2 fuzzy rules are learnt using support vector regression and an efficient closed-form type reduction strategy is used to simplify the computations. Support vector regression improved the generalisation performance of the fuzzy rule-based system in which the fuzzy rules were a set of interpretable IF-THEN rules. The performance of the proposed model was demonstrated by conducting case studies for the non-linear system approximation and prediction of chaotic time series. The model yielded promising results and the simulation results are compared to the results published in the area.

Special Session: FrF3-4 Brain and Physiological Computation for Affective Computing

Friday, July 11, 1:30PM-3:30PM, Room: 201D, Chair: Toshihiko Watanabe and Faiyaz Doctor

1:30PM *Spatiotemporal Human Brain Activities on Recalling Body Parts [#F-14241]*

Takahiro Yamanoi, Yoshinori Tanaka, Mika Otsuki, Hisahsi Toyoshima and Toshimasa Yamazaki, Hokkai Gakuen University, Japan; Japan Technical Software, Japan; Hokkaido University, Japan; Kyushu Institute of Technology, Japan

The authors measured electroencephalograms (EEGs) from subjects looking at line drawings of body parts and recalling their names silently. The equivalent current dipole source localization (ECDL) method is applied to the event related potentials (ERPs): summed EEGs. ECDs are localized to the primary visual area V1, to the ventral pathway (ITG: Inferior Temporal Gyrus), to the parahippocampus (ParaHip), the right angular gyrus (AnG), to the right supramarginal gyrus (SMG) and to the Wernike's area. Then ECDs are localized to the Broca's area, to the postcentral gyrus (PstCG) and to the fusiform gyrus (FuG), and again to the Broca's area. These areas are related to the integrated process of visual recognition of pictures and the retrieval of words. Some of these areas are also related to image recognition and word generation. And process of search and preservation in the memory is done from the result of some ECDs to the paraHip.

1:50PM *An Interactive Evolutionary Computation Framework Controlled via EEG Signals [#F-14242]*

Shen Ren, Jiangjun Tang, Michael Barlow and Hussein A. Abbass, The University of New South Wales, Australia

This paper presents an EEG-based interactive genetic algorithm framework, with the goal of leveraging EEG signals collected from a human expert involved in the evaluation of interactive genetic algorithm as inputs for genetic parameter control. We explain the framework of the system and our cognitive model constructed based on a 19 channel EEG system. An experiment has been performed to test the effectiveness of our framework and our cognitive model. Our work is the first attempt to combine brain-computer interaction with interactive evolutionary computation and parameter control.

2:10PM *Ocular Artifact Removal from EEG Using ANFIS [#F-14337]*

Wei Chen, Ze Wang, Ka Fai Lao and Feng Wan, University of Macau, Macau

Electroencephalogram (EEG) signals are often contaminated with various artifacts, especially electrooculogram (EOG) or ocular artifacts that cannot be avoided consciously and largely degrade the clinical interpretation of the signals. This paper presents a study on adaptive noise cancellation (ANC) based on adaptive neuro-fuzzy inference system (ANFIS) for EOG artifacts removal, especially when time delay is significant and on real contaminated EEG signal. The performance is first evaluated using simulated EEG and EOG signals, further investigation on the effect of time delay and tests on real data are also performed. The results illustrate that ANFIS provides a promising approach to ocular artifact removal with the best performance in comparison with ANC using adaptive filtering and ADALINE.

2:30PM *Description of Activity of Living Neuronal Network by Fuzzy Bio-Indicator [#F-14530]*

Isao Hayashi and Suguru N. Kudoh, Kansai University, Japan; Kwansei Gakuin University, Japan

The culture dish describes the small fundamental world resembling human brain function. Multi-site recording system for extracellular action potentials is used for recording the activity of living neuronal networks. The living neuronal network is able to express several patterns independently, and that's meaning that it has fundamental mechanisms for intelligent information processing. In this paper, we propose a model to analyse logicality of signals and connectivity of electrodes in a culture dish of rat hippocampal neurons. We call it "fuzzy bio-indicator". This indicator is a kind of mapping methods to show logicality and connectivity of pulse frequency from active potential of neuronal network. We try to analyze the dynamics of action potentials of neuronal networks by the fuzzy bio-indicator, and identify the logicality and connectivity of neuronal networks through the indicator. We show here the usefulness of fuzzy bio-indicator through numerical examples and action potential detected from the culture neuronal network.

2:50PM *Human Behavioural Analysis with Self-Organizing Map for Ambient Assisted Living [#F-14460]*

Kofi Appiah, Andrew Hunter, Ahmad Lotfi, Christopher Waltham and Patrick Dickinson, Nottingham Trent University, United Kingdom; University of Lincoln, United Kingdom

This paper presents a system for automatically classifying the resting location of a moving object in an indoor environment. The system uses an unsupervised neural network (Self Organising Feature Map) fully implemented on a low-cost, low-power automated home-based surveillance system, capable of monitoring activity level of elders living alone independently. The proposed system runs on an embedded platform with a specialised ceiling-mounted video sensor for intelligent activity monitoring. The system has the ability to learn resting locations, to measure overall activity levels and to detect specific events such as potential falls. First order motion information, including first order moving average smoothing, is generated from the 2D image coordinates (trajectories). A novel edge-based object detection algorithm capable of running at a reasonable speed on the embedded platform has been developed. The classification is dynamic and achieved in real-time. The dynamic classifier is achieved using a SOFM and a probabilistic model. Experimental results show less than 20\% classification error, showing the robustness of our approach over others in literature with minimal power consumption. The head location of the subject is also estimated by a novel approach capable of running on any resource limited platform with power constraints.

3:10PM *Analysis and Extraction of Knowledge from Body Motion Using Singular Value Decomposition [#F-14277]*

Yinlai Jiang, Isao Hayashi and Shuoyu Wang, Kochi University of Technology, Japan; Kansai University, Japan

The dexterity of body motion when performing skills are being actively studied. In this paper, singular value decomposition is used to extract the dexterous features from the time-series data of body motion. A matrix is composed by overlapping the subsets of the time-series data. The left singular vectors of the matrix are extracted as the patterns of the motion and the singular values as a scalar, by which each corresponding left singular vector affects the matrix. A gesture recognition experiment, in which we categorize gesture motions with indexes of similarity and estimation that use left singular vectors, was conducted to validate the method. Furthermore, in order to understand the features better, the features of the left singular vectors were described as fuzzy sets, and fuzzy if- then rules were used to represent the knowledge.

Friday, July 11, 4:00PM-6:00PM

Special Session: FrF4-1 Recent Advances in Fuzzy-Model-Based Control Design and Analysis III

Friday, July 11, 4:00PM-6:00PM, Room: 201A, Chair: Tadanari Taniguchi

4:00PM *Non-PDC Controller Design for Takagi-Sugeno Models via Line-Integral Lyapunov Functions [#F-14223]*

Abdelmadjid Cherifi, Kevin Guelton and Laurent Arcese, Universite de Reims Champagne-Ardenne, France

This paper presents a new non Paral- lel Distributed Compensation (non-PDC) controllers design based on line-Integral Lyapunov functions for continuous-time Takagi-Sugeno (T-S) fuzzy models. The previous works are mainly based on a BMI formulation (LMI for first and second order systems only). In this paper, we show that using a property on dual system, it can be possible to formulate the design of a controller as an LMI problem for n-th order T- S systems. Two simulations are provided to show the effectiveness of the proposed approach : a numerical second order academic example and a fourth order benchmark of a single link robot with flexible joint.

4:20PM *Non-Quadratic Stabilization Of Second Order Continuous Takagi-Sugeno Descriptor Systems via Line-Integral Lyapunov Function [#F-14512]*

Raymundo Marquez, Thierry Marie Guerra, Alexandre Kruszewski and Miguel Bernal, University of Valenciennes and Hainaut Cambresis, France; Ecole Centrale de Lille, France; Sonora Institute of Technology, Mexico

In this paper, a line-integral fuzzy Lyapunov function is proposed for stability and stabilization of continuous-time Takagi-Sugeno descriptor models. The scheme enhances the relaxation due to the Lyapunov function by combining it with an application of the Finsler's lemma which allows an independent controller design up to second order systems. The proposed approach includes and outperforms former results on the same subject as shown both theoretically and via illustrative examples.

4:40PM *Brain Style Control Scheme: Simultaneous Forward and Inverse Model Identification and Controller Design [#F-14552]*

Luka Eciolaza, Tadanari Taniguchi and Michio Sugeno, European Centre for Soft Computing, Spain; Tokai University, Japan; European Centre for Soft Computing, Japan

Brain Style control scheme is presented inspired by the brains hability to implement the most efficient and robust control systems available to date. It represents the first attempt to perform simultaneous and on-line (a) forward model identification, (b) controller design and (c) inverse model learning. For that we have simultaneously implemented the concepts of Vertex Placement Principle and Feedback Error Learning. The paper contributes in our attempt to demonstrate potential of Piecewise Bilinear models for nonlinear control systems.

5:00PM *Tracking Control for a Non-Holonomic Car-Like Robot Using Dynamic Feedback Linearization Based on Piecewise Bilinear Models [#F-14390]*

Tadanari Taniguchi, Luka Eciolaza and Michio Sugeno, Tokai University, Japan; European Centre for Soft Computing, Spain

We propose a dynamic feedback linearization of a car-like robot as a non-holonomic system with a piecewise bilinear (PB) model. The approximated model is fully parametric. Input-output (I/O) dynamic feedback linearization is applied to stabilize PB control system. We also apply a method for a tracking control based on PB models to the car-like robot. Although the controller is simpler than the conventional I/O feedback linearization controller, the tracking performance based on PB model is the same as the conventional one. Examples are shown to confirm the feasibility of our proposals by computer simulations.

5:20PM *Coordinate Transformation of Takagi-Sugeno Models: Stability Conditions and Observer Canonical Forms [#F-14483]*

Horst Schulte and Soeren Georg, HTW Berlin, Department of Engineering I, Control Engineering, Germany

In this paper, Lyapunov-based stability criteria for Takagi-Sugeno models in a new coordinate system are derived. Two different cases are considered: First, a simple change of coordinates with a common similarity transformation matrix for each local model is considered. For this, a linear matrix inequality (LMI) stability criterion for the transformed system based on the original coordinates is presented. Second, a timevariant similarity transformation based on a polytopic set of similarity transformation matrices is studied and a new LMI criterion is proposed to ensure the stability of the transformed Takagi-Sugeno systems. The usefulness of the criterion is shown by numerical examples.

5:40PM *Design of Fuzzy Synergetic Controller [#F-14515]*

Chi-Hua Liu and Ming-Ying Hsiao, Fortune Institute of Technology, Taiwan

In this paper, a fuzzy synergetic control (FSC) scheme is proposed for a class of nonlinear systems with system uncertainties and external disturbances. The control law is introduced by using methods of synergetic control theory and fuzzy logic control technique. The simulations results of the proposed scheme are compared with those of the conventional sliding

mode control and synergetic control. All the simulation results demonstrate the effectiveness and feasibility of the proposed control.

Special Session: FrF4-2 New Frontiers in Clustering and its Applications -Fusion of Clustering and Other Methodologies-

Friday, July 11, 4:00PM-6:00PM, Room: 201B, Chair: Yuchi Kanzawa

4:00PM *A Maximizing Model of Bezdek-Like Spherical Fuzzy C-Means Clustering [#F-14217]*

Yuchi Kanzawa, Shibaura Institute of Technology, Japan

In this study, a maximizing model of Bezdek-type spherical fuzzy c-means clustering is proposed, which is based on the regularization of the maximizing model of spherical hard c-means. Using theoretical analysis and numerical experiments, it is shown that the proposed method is not equivalent to the minimizing model of Bezdek-type spherical fuzzy c-means, because the effect of its fuzzifier parameter is different from that found in conventional methods.

4:20PM *Fuzzy c-Regression Models Combined with Support Vector Regression [#F-14150]*

Tatsuya Higuchi and Sadaaki Miyamoto, University of Tsukuba, Japan

Fuzzy c-regression models (FCRM) give us multiple clusters and regression models of each cluster simultaneously, while support vector regression models (SVRM) involve kernel methods which enable us to analyze non-linear structure of the data. We combine these two concepts and propose the united fuzzy c-support vector regression models (FC-SVRM). In case that c is unknown, we introduce sequential regression models (SRM) into SVRM, and propose support vector sequential regression models (SVSRM). We show numerical examples to compare results from these methods.

4:40PM *Incremental Algorithms for Fuzzy Co-Clustering of Very Large Cooccurrence Matrix [#F-14331]*

Katsuhiro Honda, Daiji Tanaka and Akira Notsu, Osaka Prefecture University, Japan

Handling very large data is an important issue in FCM-type clustering and several incremental algorithms have been proved to be useful in FCM clustering. In this paper, the incremental algorithms are extended to fuzzy co-clustering of cooccurrence matrices, whose goal is to simultaneously partition objects and items considering their cooccurrence information. Single pass and online approaches are applied to fuzzy clustering for categorical multivariate data (FCCM) and fuzzy CoDoK, which try to maximize the aggregation degrees of co-clusters adopting entropy-based and quadratic-based membership fuzzifications. Several experimental results demonstrate the applicability of the incremental approaches to fuzzy co-clustering algorithms.

5:00PM *Fuzzy Co-Clustering of Vertically Partitioned Cooccurrence Data with Privacy Consideration [#F-14333]*

Katsuhiro Honda, Toshiya Oda and Akira Notsu, Osaka Prefecture University, Japan

This paper considers fuzzy co-clustering of distributed cooccurrence data, where vertically partitioned cooccurrence information among objects and items are stored in several sites. In order to utilize such distributed data sets without fear of information leaks, a privacy preserving procedure is introduced to fuzzy clustering for categorical multivariate data (FCCM). Withholding each element of cooccurrence matrices, only object memberships are shared by multiple sites and their (implicit) joint co-cluster structures are revealed through an iterative clustering process. Several experimental results demonstrate the ability of improving the individual co-clustering results of each site by combining the distributed data sets.

5:20PM *FCM-Type Fuzzy Co-Clustering by K-L Information Regularization [#F-14334]*

Katsuhiro Honda, Shunnya Oshio and Akira Notsu, Osaka Prefecture University, Japan

Fuzzy c-Means (FCM) clustering by entropy-based regularization concept is a fuzzy variant of Gaussian mixtures density estimation. FCM was also extended to a full-parameter model by introducing Mahalanobis distance and the K-L information-based fuzzification scheme, in which the degree of fuzziness of partition is evaluated comparing with Gaussian mixtures. In this paper, a new fuzzy co-clustering model is proposed, which is a fuzzy variant of multinomial mixture density estimation. Multinomial mixtures is a probabilistic model for co-clustering of cooccurrence matrices and the proposed method extends multinomial mixtures so that the degree of fuzziness can be tuned in a similar manner to K-L information-based FCM. Several experimental results demonstrate the effects of tuning the degree of fuzziness comparing with its corresponding probabilistic model.

5:40PM *Stochastic Gradient Descent Based Fuzzy Clustering for Large Data [#F-14344]*

Yangtao Wang, Lihui Chen and Jianping Mei, Nanyang Technological University, Singapore; Zhejiang University of Technology, China

Data is growing at an unprecedented rate in commercial and scientific areas. Clustering algorithms for large data which require small memory consumption and scalability become increasingly important under this circumstance. In this paper, we propose a new clustering approach called stochastic gradient based fuzzy clustering(SGFC) which achieves the optimization based on stochastic approximation to handle such kind of large data. We derive an adaptive learning rate which can be updated incrementally and maintained automatically in gradient descent approach employed in SGFC. Moreover, SGFC is extended to a mini-batch SGFC to reduce the stochastic noise. Additionally, multiple-pass SGFC is also proposed to improve the clustering performance. Experiments have been conducted on synthetic data to show the effectiveness of our derived adaptive learning rate. Experimental studies have been also conducted on several large benchmark datasets including real world image and document datasets. Compared with existing fuzzy clustering approaches for large data, the mini-batch SGFC shows comparable or better accuracy with significant less time consumption. These results demonstrate the great potential of SGFC for large data analysis.

FrF4-3 Fuzzy Logic & Fuzzy Set Theory II

Friday, July 11, 4:00PM-6:00PM, Room: 201C, Chair: Fuchun Sun and Plamen Angelov

4:00PM *Regularization-Based Learning of the Choquet Integral [#F-14162]*

Derek Anderson, Stanton Price and Timothy Havens, Mississippi State University, United States; Michigan Technological University, United States

A number of data-driven fuzzy measure (FM) learning techniques have been put forth for the fuzzy integral (FI). Examples include quadratic programming, Gibbs sampling, gradient descent, reward and punishment and evolutionary optimization. However, most approaches focus solely on the minimization of the sum of squared error (SSE). Limited attention has been placed on characterizing and subsequently minimizing model (i.e., FM) complexity. Furthermore, the vast majority of learning techniques are highly susceptible to overfitting and noise. Herein, we explore a regularization approach to learning the FM for the Choquet FI. We investigate the mathematical motivation for such an approach, its applicability and impact on different types of FMs, and its desirable properties for quadratic programming (QP) based optimization. We show that L1 regularization has a distinct meaning for measure learning and aggregation operators. Experiments are performed and validated with respect to the Shapley index. Specifically, we show that it is possible to reduce the effect of overfitting, we can identify higher quality measures and, if desired, force the learning of fewer numbers of sources.

4:20PM *Uniformly Strongly Prime Fuzzy Ideals [#F-14311]*

Flaulles Bergamaschi and Regivan Santiago, Southwest Bahia State University, Brazil; Federal University of Rio Grande do Norte, Brazil

In this paper we define the concept of uniformly strongly prime fuzzy ideal for associative rings with unity. This concept is proposed without dependence of level cuts. We show a pure fuzzy demonstration that all uniformly strongly prime fuzzy ideals are a prime fuzzy ideal according to the newest definition given by Navarro, Cortadellas and Lobillo in 2012. Also, some properties about fuzzy strongly prime radical and their relations with Zadeh's extension are shown.

4:40PM *Ranking Fuzzy Numbers by Their Expansion Center [#F-14308]*

Zhenyuan Wang and Li Zhang-Westman, University of Nebraska at Omaha, United States

Based on the area between the curve of the membership function and the horizontal real axes, a new index, called the expansion center, for fuzzy numbers is proposed. An intuitive and reasonable ranking method for fuzzy numbers based on their expansion center is also established. This new ranking method is useful in fuzzy decision making and fuzzy data mining.

5:00PM *Rotation of Triangular Numbers via Quaternion [#F-14316]*

Ronildo Moura, Flaulles Bergamaschi, Regivan Santiago and Benjamin Bedregal, Federal University of Rio Grande do Norte, Brazil; Southwest Bahia State University, Brazil

In this paper we introduced the concept of three-dimensional triangular fuzzy number and their properties are investigated. It is shown that this set has important metrical properties, e.g convexity. The paper also provides a rotation method for such numbers based on an aggregation operator.

5:20PM *Ontology-Based Service Matching in Cloud Computing [#F-14254]*

Li Liu, Xiaofen Yao, Liangjuan Qin and Miao Zhang, University of Science and Technology Beijing, China; University of International Business and Economics, China

This paper focuses on how to maximize accuracy of Cloud service discovery and give enough flexibility to Cloud customers to discover their best suited services from a range of Cloud providers. An ontology-based Cloud service discovery approach is proposed, which works based on modelling semantically enriched Cloud services, ontology reasoning and logic matchmaking. Cloud customers have different preferences for non-functional attributes, ranking discovered services according their preference can help select the most appropriate cloud service. Experimental results show that the discovered services not only meet customer's requirements in semantics but also satisfy the QoS demands given in the terms of SLA

5:40PM *Interval Type-2 Fuzzy Modeling and Chaotic Synchronization of Two Different Memristor-Based Lorenz Circuits [#F-14283]*

Tsung-Chih Lin and Fu-Yu Huang, Feng-Chia University, Taiwan

This paper considers the interval type-2 T-S fuzzy modeling and chaotic synchronization of two different memristor-based Lorenz circuits. In this paper, memristor-based Lorenz circuit is constructed by adding a flux-controlled memristor and phase portraits of the state variables are presented. In the meantime, an interval type-2 Takagi-Sugeno (T-S) fuzzy modeling of memristor-based Lorenz circuit proposed and the numerical simulations of the system's solution and the phase portraits are presented. Finally, the synchronization between two different memristor-based Lorenz circuits is achieved by using the proposed fuzzy controller.

FrF4-4 Fuzzy Models

Friday, July 11, 4:00PM-6:00PM, Room: 201D, Chair: Petrica C. Pop and Dimitar Filev

4:00PM *Learning Fuzzy Rules through Ant Optimization, LASSO and Dirichlet Mixture [#F-14306]*

Arturo Garcia-Garcia and Andres Mendez-Vazquez, CINVESTAV, Mexico

In the area of fuzzy systems, one of the main problems is finding the set of rules that can give us the best results in specific problems. Further, the finding of this set is a combinatorial problem. There are several techniques for building these sets, but it is possible to group them in two main classes: The bottom-up approaches and the top-down approaches. This work proposes a new top-down approach to the fuzzy systems learning based in clustering and optimization techniques. The algorithm is split in two stages: First, it determines the fuzzy sets of each input and output linguistic variable, and second, it calculates the fuzzy rules from the obtained fuzzy sets. For the first part, a Dirichlet Mixture (DM) is used to cluster data to assign a fuzzy sets to each new cluster, since a fuzzy set can be seen as a generalized probability function, and hence the fuzzy sets of a given linguistic variable can be seen as a mixture of probabilities (a Gaussian Mixture). Then, an optimization problem is solved by using Ant Colony Optimization (ACO) to generate the minimum set of possible rules for classification and using a version of the Least Absolute Shrinkage and Selection Operator(LASSO) for the fitness function. This ACO was implemented in a CUDA GPU to deal with the combinatorial problem of rule generation. Finally, this new algorithm is used to deal with the problem of color image segmentation.

4:20PM *Prediction of Online Trade Growth Using Search-ANFIS: Transactions on Taobao as Examples [#F-14012]*

Jiyuan Wang, Geng Peng and Wei Dai, University of Chinese Academy of Sciences, China

The growth of E-commerce which can be seen in recent years, has contributed a lot to global economy. Prediction of trade, especially in C2C market, can help decision-makers obtain the information from the online

transactions and find the knowledge underlying the data. This paper facilities the traditional search index prediction system with ANFIS model. By using purchasing transactions from Taobao, a C2C company in China, this paper trains and tests the model. Results show that, compared with traditional regression analysis method, Search-ANFIS system has higher prediction accuracy in online trade prediction.

4:40PM *Granular Cognitive Maps Reconstruction [#F-14300]*

Homenda Wladyslaw, Jastrzebska Agnieszka and Pedrycz Witold, Warsaw University Technology, Poland; Systems Research Institute, Polish Academy of Sciences, Poland

Cognitive Maps are abstract knowledge representation framework, suitable to model complex systems. Cognitive Maps are visualized with directed graphs, where nodes represent phenomena and edges represent relationships. Granular Cognitive Maps are augmented Cognitive Maps, which use knowledge granules as information representation model. Conceptually, GCMs originated as an extension of Fuzzy Cognitive Maps. The contribution presented in this paper is a methodology for Granular Cognitive Map reconstruction. The goal of the procedure is to construct a weights matrix - and thereby the GCM, which outputs best describe the phenomena of interest. The article addresses the conflict between generality and specificity of various Granular Cognitive Maps. Balance between generality and specificity is the most important architectural aspect of a model built with knowledge granules. A series of experiments illustrates, how various optimization techniques allow improvement in map's quality without a loss in map's precision.

5:00PM *Fuzzy Multi-Objective Reliability-Redundancy Allocation Problem [#F-14544]*

Ashraf Zubair, Pranab Muhuri, Q. M. Danish Lohani and Rahul Nath, South Asian University, India

-- Reliability is the measure of the result of the quality of the system over a long run. The reliability-redundancy allocation problem (RRAP) aims to ensure high systems reliability in the presence of optimally redundant systems components. This is one of the most important design considerations for the systems designers. Several researchers have addressed this important issue during last few decades. However, due to the embedded uncertainty in the parameters of the system components, reliability as well as the costs of the whole system fits very well to be modelled as fuzzy quantity. We therefore modelled this problem as a fuzzy multi-objective optimization problem (MORRAP) that is addressed using a popular multi-objective evolutionary algorithm, viz. non-dominated sorting genetic algorithm-II. We have considered the based MORRAP with fuzzy type-2 uncertainty. As far as we know, no research has been reported where MORRAP was considered under type-2 fuzzy uncertainty. A typical numerical example is included and results are compared showing that our approach outperforms other recently reported results.

5:20PM *On the Resilience of an Ant-Based System in Fuzzy Environments. An Empirical Study [#F-14272]*

Gloria Cerasela Crisan, Camelia-M. Pintea and Petrica C. Pop, Vasile Alecsandri University of Bacau, Romania; Technical University Cluj-Napoca, North University Center Baia-Mare, Romania

The current work describes an empirical study conducted in order to investigate the behavior of an optimization method in a fuzzy environment. MAX-MIN Ant System, an efficient implementation of a heuristic method is used for solving an optimization problem derived from the Traveling Salesman Problem (TSP). Several publicly-available symmetric TSP instances and their fuzzy variants are tested in order to extract some general features. The entry data was adapted by introducing a two-dimensional systematic degree of fuzziness, proportional with the number of nodes, the dimension of the instance and also with the distances between nodes, the scale of the instance. The results show that our proposed method can handle the data uncertainty, showing good resilience and adaptability.

5:40PM *An Investigation of Methods of Parameter Tuning For Q-Learning Fuzzy Inference System [#F-14305]*

Ahmad Al-Talabi and Howard Schwartz, Carleton University, Canada

This paper investigates four methods of implementing a Q-Learning Fuzzy inference System(QFIS) algorithm to autonomously tune the parameters of a fuzzy inference system. We use an actor-critique structure and we simulate mobile robots playing the differential form of the pursuit evasion game. Both the critique and the actor are fuzzy inference systems. The four methods come from the fact whether it is necessary to tune all the parameters (i.e. all the premise and the consequent parameters) of the critique and the actor or just tune their consequent parameters. The four methods are applied to three versions of the pursuit evasion games. In the first version just the pursuer is learning. In the second version, the evader uses its higher maneuverability and plays intelligently against a self-learning pursuer. In the final version, both the pursuer and the evader are learning. We evaluate which parameters are best to tune and which parameters have little impact on the performance.

DETAILED PROGRAM (IEEE CEC 2014)

Monday, July 7, 1:30PM-3:30PM

Special Session: MoE1-1 Computational Intelligence and Games

Monday, July 7, 1:30PM-3:30PM, Room: 203A, Chair: Kyung-Joong Kim and Sung-Bae Cho

1:30PM *Learning a Super Mario Controller from Examples of Human Play [#E-14063]*

Geoffrey Lee, Min Luo, Fabio Zambetta and Xiaodong Li, RMIT University, Australia

Imitating human-like behaviour in action games is a challenging but intriguing task in Artificial Intelligence research, with various strategies being employed to solve the human-like imitation problem. In this research we consider learning human-like behaviour via Markov decision processes without being explicitly given a reward function, and learning to perform the task by observing expert's demonstration. Individual players often have characteristic styles when playing the game, and this method attempts to find the behaviours which make them unique. During play sessions of Super Mario we calculate player's behaviour policies and reward functions by applying inverse reinforcement learning to the player's actions in game. We conduct an online questionnaire which displays two video clips, where one is played by a human expert and the other is played by the designed controller based on the player's policy. We demonstrate that by using apprenticeship learning via Inverse Reinforcement Learning, we are able to get an optimal policy which yields performance close to that of an human expert playing the game, at least under specific conditions.

1:50PM *Integrating Fuzzy Integral and Heuristic Search for Unit Micromanagement in RTS Games [#E-14566]*

Tung Nguyen, Kien Nguyen and Ruck Thawonmas, Ritsumeikan University, Japan

Real-time strategy (RTS) is a sub-genre of strategy video game which typically involves resource gathering, base building, strategy planning, and combat scenarios. With complicated gameplay, vast state and action spaces, RTS games have been proven to be an excellent platform for artificial intelligence research. One of the most challenging problems posed by RTS games is the detailed control of units in combat, i.e., unit micromanagement. In this paper, we present a method of integrating fuzzy integral and fast heuristic search for improving the quality of unit micromanagement in the popular RTS game StarCraft. Experiments are reported at the end of this paper, showing promising results and the potential of the proposed method in this domain.

2:10PM **Tego - A Framework for Adversarial Planning [#E-14578]*

Daniel Ashlock and Philip Hingston, University of Guelph, Canada; Edith Cowan University, Australia

This study establishes a framework called *-Tego for a situation in which two agents are each given a set of players for a competitive game. Each agent places their players in an order. Players on each side at the same position in the order play one another, with the agent's score being the sum of their player's scores. The planning agents are permitted to simultaneous reorder their players in each of several stages. The reordering is termed competitive replanning. The resulting framework is scalable by changing the number of players and the complexity of the replanning process. The framework is demonstrated using iterated prisoner's dilemma on a set of twenty players. The system is first tested with one agent unable to change the order of its players, yielding an optimization problem. The system is then tested in a competitive co-evolution of planning agents. The optimization form of the system makes globally sensible assignments of players. The co-evolutionary version concentrates on matching particular high-payoff pairs of players with the agents repeatedly reversing one another's assignments, with the majority of players with smaller payoffs at risk are largely ignored.

2:30PM *TURAN: Evolving Non-Deterministic Players for the Iterated Prisoner's Dilemma [#E-14697]*

Marco Gaudesi, Elio Piccolo, Giovanni Squillero and Alberto Tonda, Politecnico di Torino, Italy; Institut National de la Recherche Agronomique, France

The iterated prisoner's dilemma is a widely known model in game theory, fundamental to many theories of co- operation and trust among self-interested beings. There are many works in literature about developing efficient strategies for this problem, both inside and outside the machine learning community. This paper shift the focus from finding a "good strategy" in absolute terms, to dynamically adapting and optimizing the strategy against the current opponent. Turan evolves competitive non-deterministic models of the current opponent, and exploit them to predict its moves and maximize the payoff as the game develops. Experimental results show that the proposed approach is able to obtain good performances against different kind of opponent, whether their strategies can or cannot be implemented as finite state machines.

2:50PM *Evolving a Fuzzy Goal-Driven Strategy for the Game of Geister [#E-14704]*

Andrew Buck, Tanvi Banerjee and James Keller, University of Missouri, United States

This paper presents an approach to designing a strategy for the game of Geister using the three main research areas of computational intelligence. We use a goal- based fuzzy inference system to evaluate the utility of possible actions and a neural network to estimate unobservable features (the true natures of the opponent ghosts). Finally, we develop a coevolutionary algorithm to learn the parameters of the strategy. The resulting autonomous gameplay agent was entered in a global competition sponsored by the IEEE Computational Intelligence Society and finished second among eight participating teams.

3:10PM *Deep Boltzmann Machine for Evolutionary Agents of Mario AI [#E-14805]*

Hisashi Handa, Kindai University, Japan

Deep Learning has attracted much attention recently since it can extract features taking account into the high-order knowledge. In this paper, we examine the Deep Boltzmann Machines for scene information of the Mario AI Championship. That is, the proposed method is composed of two parts: the DBM and a recurrent neural network. The DBM extracts features behind perceptual scene information, and it learns off-line. On the other hand, the recurrent neural network utilizes features to decide actions of the Mario AI agents, and it learns on-line by using Particle Swarm Optimization. Experimental results show the effectiveness of the proposed method.

Special Session: MoE1-2 Memetic Computing

Monday, July 7, 1:30PM-3:30PM, Room: 203B, Chair: Zexuan Zhu and Wenyin Gong

1:30PM *A Memetic Algorithm for Solving Permutation Flow Shop Problems with Known and Unknown Machine Breakdowns [#E-14048]*

Humyun Fuad Rahman, Ruhul Sarker, Daryl Essam and Guijuan Chang, University of New South Wales, Australia; Qingdao Agricultural University, China

The Permutation Flow Shop Scheduling Problem (PFSP) is considered to be one of the complex combinatorial optimization problems. For PFSPs, the schedule is produced under ideal conditions that usually ignore any type of process interruption. In practice, the production process is interrupted due to many different reasons, such as machine unavailability and breakdowns. In this paper, we propose a Genetic Algorithm (GA) based approach to deal with process interruptions at different points in time in Permutation Shop Floor scenarios. We have considered two types of process interruption events. The first one is predictive, where the interruption information is known well in advance, and the second one is reactive, where the interruption information is not known until the breakdown occurs. An extensive set of experiments has been carried out, which demonstrate the usefulness of the proposed approach.

1:50PM *Remote Sensing Imagery Clustering Using an Adaptive Bi-Objective Memetic Method [#E-14130]*

Ailong Ma, Yanfei Zhong and Liangpei Zhang, Wuhan University, China

Due to the intrinsic complexity of the remote sensing image and the lack of the prior knowledge, clustering for remote sensing image has always been one of the most challenging works in remote sensing image processing. The proposed algorithm constructs a bi-objective memetic-based framework, exploiting the feature space more efficiently. In the framework, two objective functions, Jm and XB, are used as the objective functions for bi-objective optimization. Furthermore, an adaptive local search method which can dynamically adjust its parameter value according to the selection probability has been developed and incorporated into the proposed algorithm. In order to speed the convergence and obtain more non-dominated solutions in the pareto front, a new strategy is newly devised in the local search process, which considers more solutions as the candidate for the next generation. To evaluate the proposed algorithm, some experiments on two multi-spectral images are conducted. The results show that the proposed algorithm can achieve better performance, compared with related methods.

2:10PM *A Memetic Algorithm Based on Immune Multi-Objective Optimization for Flexible Job-Shop Scheduling Problems [#E-14246]*

Jingjing Ma, Yu Lei, Zhao Wang and Licheng Jiao, Xidian University, China

The flexible job-shop scheduling problem (FJSP) is an extension of the classical job scheduling which is concerned with the determination of a sequence of jobs, consisting of many operations, on different machines, satisfying parallel goals. This paper addresses the FJSP with two objectives: Minimize makespan, Minimize total operation cost. We introduce a memetic algorithm based on the Nondominated Neighbor Immune Algorithm (NNIA), to tackle this problem. The proposed algorithm adds, to NNIA, local search procedures including a rational combination of undirected simulated annealing (UDSA) operator, directed cost simulated annealing (DCSA) operator and directed makespan simulated annealing (DMSA) operator. We have validated its efficiency by evaluating the algorithm on multiple instances of the FJSPs. Experimental results show that the proposed algorithm is an efficient and effective algorithm for the FJSPs, and the combination of UDSA operator, DCSA operator and DMSA operator with NNIA is rational.

2:30PM *A Memetic Algorithm for Solving Flexible Job-Shop Scheduling Problems [#E-14247]*

Wenping Ma, Yi Zuo, Jiulin Zeng, Shuang Liang and Licheng Jiao, Xidian University, China

The flexible Job-shop Scheduling Problem (FJSP) is an extension of the classical job-shop scheduling problem (JSP). In this paper, a memetic algorithm (MA) for the FJSP is presented. This MA is a hybrid genetic algorithm which explores the search space and two efficient local searchers to exploit information in the search region. An extensive computational study on 49 benchmark problems shows that the algorithm is effective and robust, with respect to other well-known effective algorithms.

2:50PM *Hybridizing the Dynamic Mutation Approach with Local Searches to Overcome Local Optima [#E-14299]*

Kuai Wei and Michael J. Dinneen, University of Auckland, New Zealand

A Memetic Algorithm is an Evolutionary Algorithm augmented with local searches. The dynamic mutation approach has been studied extensively in experiments of Memetic Algorithms, but only a few studies in theory. We previously defined a metric BLOCKONES to estimate the difficulty of escaping from a local optima. An algorithm's ability of escaping from a local optima that has a large BLOCKONES is very important because it dominates the time complexity of finding a global optimal solution. In this paper, we will use the same metric and show the benefits of hybridizing the dynamic mutation approach with one of two local searches, best-improvement and first-improvement. In short, this hybridization greatly enhances the algorithm's ability to escape from any local optima.

3:10PM *Memetic Algorithm with Adaptive Local Search Depth for Large Scale Global Optimization [#E-14493]*

Can Liu and Bin Li, University of Science and Technology of China, China

Memetic algorithms (MAs) have been recognized as an effective algorithm framework for solving optimization problems. However, the exiting work mainly focused on the improvement for search operators. Local Search Depth (LSD) is a crucial parameter in MAs, which controls the computing resources assigned for local search. In this paper, an Adaptive Local Search Depth (ALSD) strategy is proposed to arrange the computing resources for local search according to its performance dynamically. A Memetic Algorithm with ALSD (MA-ALSD) is presented, its performance and the effectiveness of ALSD are testified via experiments on the LSGO test suite issued in CEC'2012.

Special Session: MoE1-3 Evolutionary Computer Vision

Monday, July 7, 1:30PM-3:30PM, Room: 203C, Chair: Mengjie Zhang, Vic Ciesielski and Mario Koppen

1:30PM *Neural Network Ensembles for Image Identification Using Pareto-Optimal Features [#E-14277]*

Wissam A. Albukhanajer, Yaochu Jin and Johann A. Briffa, University of Surrey, United Kingdom

In this paper, an ensemble classifier is constructed for invariant image identification, where the inputs to the ensemble members are a set of Pareto-optimal image features extracted by an evolutionary multi-objective Trace transform algorithm. The Pareto-optimal feature set, called Triple features, gains various degrees of trade-off between sensitivity and invariance. Multilayer perceptron neural networks are adopted as ensemble members due to their simplicity and capability for pattern classification. The diversity of the ensemble is mainly achieved by the Pareto-optimal features extracted by the multi-objective evolutionary Trace transform. Empirical results show that the general performance of proposed ensemble classifiers is more robust to geometric deformations and noise in images compared to single neural network classifiers using one image feature.

1:50PM *Automatic Evolutionary Medical Image Segmentation Using Deformable Models [#E-14517]*

Andrea Valsecchi, Pablo Mesejo, Linda Marrakchi-Kacem, Stefano Cagnoni and Sergio Damas, European Centre for Soft Computing, Spain; University of Parma, Italy; Neurospin, France

This paper describes a hybrid level set approach to medical image segmentation. The method combines region- and edge-based information with the prior shape knowledge introduced using deformable registration. A parameter tuning mechanism, based on Genetic Algorithms, provides the ability to automatically adapt the level set to different segmentation tasks. Provided with a set of examples, the GA learns the correct weights for each image feature used in the segmentation. The algorithm has been tested over four different medical datasets across three image modalities. Our approach has shown significantly more accurate results in comparison with six state-of-the-art segmentation methods. The contribution of both the image registration and the parameter learning steps to the overall performance of the method has also been analyzed.

2:10PM *Cost-Sensitive Texture Classification [#E-14581]*

Gerald Schaefer, Bartosz Krawczyk, Niraj Doshi and Tomoharu Nakashima, Loughborough University, United Kingdom; Wroclaw University of Technology, Poland; Osaka Prefecture University, Japan

Texture recognition plays an important role in many computer vision tasks including segmentation, scene understanding and interpretation, medical imaging and object recognition. In some situations, the correct identification of particular textures is more important compared to others, for example recognition of enemy uniforms for automatic defense systems, or isolation of textures related to tumors in medical images. Such cost-sensitive texture classification is the focus of this paper, which we address by reformulating the classification problem as a cost minimisation problem. We do this by constructing a cost-sensitive classifier ensemble that is tuned using a genetic algorithm. Based on experimental results obtained on several Outex datasets with cost definitions, we show our approach to work well in comparison with canonical classification methods and the ensemble approach to lead to better performance compared to single predictors.

2:30PM *Genetic Algorithms Based Feature Combination for Salient Object Detection, for Autonomously Identified Image Domain Types [#E-14867]*

Syed Saud Naqvi, Will N. Browne and Christopher Hollitt, Victoria University of Wellington, New Zealand

Combining features from different modalities and domains has been demonstrated to enhance the performance of saliency prediction algorithms. Different feature combina- tions are often suited to different types of images, but exist- ing techniques attempt to apply a single feature combination across all image types. Furthermore, existing normalization and integration schemes are not utilized in salient object detec- tion as the combination of potential solutions is intractable to test. The aim of this work is to autonomously learn feature combinations for autonomously identified image types. To this end, we learn optimal normalization and integration schemes along with feature weightings using a novel Genetic Algorithm (GA) method. Moreover, we learn multiple image dependent parameters using our novel image-based GA (IGA) approach, to increase the generalization of the system on unseen test images. We present a thorough quantitative and qualitative comparison of our proposed methods with the state-of-the-art benchmark and deterministic methods on two difficult datasets (SED1 and SED2) from the segmentation evaluation database. IGA shows superior performance through learning optimal parameters depending upon the composition of images and using feature combinations appropriately enhances test performance and generalization of the system.

2:50PM *Unsupervised Learning for Edge Detection Using Genetic Programming [#E-14462]*

Wenlong Fu, Mark Johnston and Mengjie Zhang, Victoria University of Wellington, New Zealand

In edge detection, a machine learning algorithm generally requires training images with their ground truth or designed outputs to train an edge detector. Meanwhile the computational cost is heavy for most supervised learning algorithms in the training stage when a large set of training images is used. To learn edge detectors without ground truth and reduce the computational cost, an unsupervised Genetic Programming (GP) system is proposed for low-level edge detection. A new fitness function is developed from the energy functions in active contours. The proposed GP system utilises single images to evolve GP edge detectors, and these evolved edge detectors are used to detect edges on a large set of test images. The results of the experiments show that the proposed unsupervised learning GP system can effectively evolve good edge detectors to quickly detect edges on different natural images.

Special Session: MoE1-4 Theoretical Foundations of Bio-inspired Computation

Monday, July 7, 1:30PM-3:30PM, Room: 203D, Chair: Pietro Oliveto

1:30PM *Single- and Multi-Objective Genetic Programming: New Runtime Results for SORTING [#E-14201]*

Markus Wagner and Frank Neumann, The University of Adelaide, Australia

In genetic programming, the size of a solution is typically not specified in advance and solutions of larger size may have a larger benefit. The flexibility often comes at the cost of the so-called bloat problem: individuals grow without providing additional benefit to the quality of solutions, and the additional elements can block the optimisation process. Consequently, problems that are relatively easy to optimise cannot be handled by variable-length evolutionary algorithms. In this article, we present several new bounds for different single- and multi-objective algorithms on the sorting problem, a problem that typically lacks independent and additive fitness structures.

1:50PM *Runtime Comparison of Two Fitness Functions on a Memetic Algorithm for the Clique Problem [#E-14298]*

Kuai Wei and Michael J. Dinneen, University of Auckland, New Zealand

It is commonly accepted that a proper fitness funtion can guide the algorithm to find a global optimum solution faster. This paper will use the runtime analysis to provide the theoretical evidence that a small change of the fitness function can result in a huge performance gap in terms of finding a global optimum solution. It also shows that the fitness function that gives the best results in an Memetic Algorithm on the Clique Problem is entirely instance specific. In detail, we will formalize a (1+1) Restart Memetic Algorithm with a Random Complete Local Search, and run them on two different fitness functions, f_OL and f_OPL, to solve the Clique Problem respectively. We then construct two families of graphs, G_1 and G_2, and show that, for the first family of graphs G_1, the (1+1) RMA on the fitness function f_OPL drastically outperforms the (1+1) RMA on the fitness function f_OL, and vice versa for the second family of graphs G_2.

2:10PM *A Theoretical Assessment of Solution Quality in Evolutionary Algorithms for the Knapsack Problem [#E-14460]*

Jun He, Mitavskiy Boris and Yuren Zhou, Aberystwyth University, United Kingdom; South China University of Technology, China

Evolutionary algorithms are well suited for solving the knapsack problem. Some empirical studies claim that evolutionary algorithms can produce good solutions to the 0-1 knapsack problem. Nonetheless, few rigorous investigations address the quality of solutions that evolutionary algorithms may produce for the knapsack problem. This paper focuses on a theoretical investigation of three types of (N+1) evolutionary algorithms that exploit bitwise mutation, truncation selection, plus different repair methods for the 0-1 knapsack problem. It assesses the solution quality in terms of the approximation ratio. Our work indicates that the solution produced by both pure strategy and mixed strategy evolutionary algorithms is arbitrarily bad. Nevertheless, an evolutionary algorithm using helper objectives may produce 1/2-approximation solutions to the 0-1 knapsack problem.

2:30PM *The Sampling-and-Learning Framework: A Statistical View of Evolutionary Algorithms [#E-14491]*

Yang Yu and Hong Qian, Nanjing University, China

Evolutionary algorithms (EAs), a large class of general purpose optimization algorithms inspired from the natural phenomena, are widely used in various industrial optimizations and often show excellent performance. This paper presents an attempt towards revealing their general power from a statistical view of EAs. By summarizing a large range of EAs into the sampling-and-learning framework, we show that the framework directly admits a general analysis on the probable-absolute-approximate (PAA) query complexity. We particularly focus on the framework with the learning subroutine being restricted as a binary classification, which results in the sampling-and-classification (SAC) algorithms. With the help of the learning theory, we obtain a general upper bound on the PAA query complexity of SAC algorithms. We further compare SAC algorithms with the uniform search in different situations. Under the error-target independence condition, we show that SAC algorithms can achieve polynomial speedup to the uniform search, but not super-polynomial speedup. Under the one-side-error condition, we show that super- polynomial speedup can be achieved. This work only touches the surface of the framework. Its power under other conditions is still open.

2:50PM *Markov Chain Analysis of Evolution Strategies on a Linear Constraint Optimization Problem [#E-14862]*

Alexandre Chotard, Anne Auger and Nikolaus Hansen, University Paris-Sud, France

This paper analyses a $(1,\lambda)$-Evolution Strategy, a randomised comparison-based adaptive search algorithm, on a simple constraint optimization problem. The algorithm uses resampling to handle the constraint and optimizes a linear function with a linear constraint. Two cases are investigated: first the case where the step-size is constant, and second the case where the step-size is adapted using path length control. We exhibit for each case a Markov chain whose stability analysis would allow us to deduce the divergence of the algorithm depending on its internal parameters. We show divergence at a constant rate when the step-size is constant. We sketch that with step-size adaptation geometric divergence takes place. Our results complement previous studies where stability was assumed.

3:10PM *Free Lunch for Optimisation under the Universal Distribution [#E-14666]*

Tom Everitt, Tor Lattimore and Marcus Hutter, Stockholm University, Sweden; University of Alberta, Canada; Australian National University, Australia

Function optimisation is a major challenge in computer science. The No Free Lunch theorems state that if all functions with the same histogram are assumed to be equally probable then no algorithm outperforms any other in expectation. We argue against the uniform assumption and suggest a universal prior exists for which there is a free lunch, but where no particular class of functions is favoured over another. We also prove upper and lower bounds on the size of the free lunch.

Monday, July 7, 3:30PM-6:00PM

Poster Session: PE1 Poster Session I

Monday, July 7, 3:30PM-6:00PM, Room: Posters Area (Level 2), Chair: Tadahiko Murata

P101 *Smooth Global and Local Path Planning for Mobile Robot Using Particle Swarm Optimization, Radial Basis Functions, Splines and Bezier Curves [#E-14054]*

Nancy Arana-Daniel, Alberto A. Gallegos, Carlos Lopez-Franco and Alma Y. Alanis, University of Guadalajara, Mexico

An approach to plan smooth paths for mobile robots using a Radial Basis Function (RBF) neural network trained with Particle Swarm Optimization (PSO) was presented before by the authors. Taking the previous approach as an starting point, in this paper it is shown that it is possible to construct a smooth simple global path and then modify this path locally using PSO-RBF, Ferguson splines or Bezier curves trained with PSO, in order to describe more complex paths or to deal with dynamic changes in the environment. Experimental results show that our approach is fast and effective to deal with complex environments.

P102 *A Novel Improvement of Particle Swarm Optimization Using Dual Factors Strategy [#E-14070]*

Lin Wang, Bo Yang, Yi Li and Na Zhang, University of Jinan, China; China United Network Communications Co. Ltd. Shandong Branch, China

The particle swarm optimization, inspired by nature, is widely used for optimizing complex problems and achieves many good stories in practical applications. However, the traditional PSO only focuses on the function value during evolutionary process. It ignores the information of distance between particles and potential regions. A Dual Factors Particle Swarm Optimization (DFPSO) incorporating both of distance and function information is proposed in this paper to help PSO in finding potential global optimal regions. The strategy of the DFPSO increases the diversity of population to yield improved results. The experimental results manifest that the performance, including accuracy and speed, are improved.

P103 *A Verifiable PSO Algorithm in Cloud Computing [#E-14077]*

Tao Xiang, Weimin Zhang and Fei Chen, Chongqing University, China; The Chinese University of Hong Kong, Hong Kong

In this paper, we study the verification problem of particle swarm optimization (PSO) when it is outsourced to the cloud, i.e. making sure that the cloud executes PSO algorithm as requested. A verifiable PSO algorithm and its verification algorithm are proposed. The proposed scheme does not involve expensive cryptography, and it is efficient and effective to verify the honesty of the cloud.

P104 *Space-Time Simulation Model Based on Particle Swarm Optimization Algorithm for Stadium Evacuation [#E-14079]*

Xinlu Zong, Shengwu Xiong, Hui Xu and Pengfei Duan, Hubei University of Technology, China; Wuhan University of Technology, China

In this paper, a space-time simulation model based on particle swarm optimization algorithm for stadium evacuation is presented. In this new model, the fast evacuation, going with the crowd and the panic behaviors are considered and the corresponding moving rules are defined. The model is applied to a stadium and simulations are carried out to analyze the space-time evacuation efficiency by different behaviors. The simulation results show that the behaviors of going with the crowd and panic will slow down the evacuation process while quickest evacuation psychology can accelerate the process, and panic is helpful to some extent. The setting of parameters is discussed to obtain best performance. The simulation results can offer effective suggestions for evacuees under emergency situation.

P105 *Bare Bones Particle Swarm with Scale Mixtures of Gaussians for Dynamic Constrained Optimization [#E-14086]*

Mauro Campos and Renato Krohling, Federal University of Espirito Santo, Brazil

Bare bones particle swarm optimization (BBPSO) is a well-known swarm algorithm which has shown potential for solving single-objective constrained optimization problems in static environments. In this paper, a generalized BBPSO for dynamic single-objective constrained optimization problems is proposed. An empirical study was carried out to evaluate the performance of the proposed approach. Experimental results show the suitability of the proposed algorithm in terms of effectiveness to find good solutions for all benchmark problems investigated. For comparison purposes, experimental results found by other algorithms are also presented.

P106 *Cooperative Particle Swarm Optimizer with Elimination Mechanism for Global Optimization of Multimodal Problems [#E-14106]*

Geng Zhang and Yangmin Li, University of Macau, Macau; University of Macau/Tianjin University of Technology, China

This paper presents a new particle swarm optimizer (PSO) that called the oooperative particle swarm optimizer with elimination mechanism (CPSO-EM) in an attempt to address the issue of getting trapped into local optimum when solving nonseparable multimodal problems using PSO algorithm. The proposed CPSO-EM builds on the basis of an early cooperative PSO (CPSO-H) that employs cooperative behavior. The CPSOH and elimination mechanism (EM) memory are incorporated together to obtain CPSO-EM. Experimental studies on a set of test functions show that CPSO-EM exhibits better performance in solving nonseparable multimodal problems than several other peer algorithms.

P107 *A Chaotic Particle Swarm Optimization Algorithm for the Jobshop Scheduling Problem [#E-14125]*

Ping Yan and Minghai Jiao, Shenyang Aerospace University, China; Northeastern University, China

An improved Chaotic Particle Swarm Optimization (CPSO) algorithm for a jobshop scheduling problem, with minimization of makespan as the criterion, is proposed in this research. A real-valued encoding scheme based on a matrix representation is developed, which converts the continuous position value of particles in PSO to the processing order of job operation. A compound chaotic search strategy that integrates both Tent and Logistic chaotic search process is employed to the global best particle to enhance the local searching ability of PSO. In addition, a gaussian disturbance technology is embedded in the CPSO algorithm to improve the diversity of the particles in the swarm. The performance of CPSO is compared with the standard PSO algorithm on a benchmark instance of jobshop scheduling problems. The results show that the proposed CPSO algorithm has a superior performance to the PSO algorithm.

P108 *Autonomous Learning Adaptation for Particle Swarm Optimization [#E-14144]*

Wenyong Dong, Jiangshen Tian, Xu Tang, Kang Sheng and Jin Liu, Wuhan University, China

In order to improve the performance of PSO, this paper presents an Autonomous Learning Adaptation method for Particle Swarm Optimization (ALA-PSO) to automatically tune the control parameters of each particle. Although PSO is an ideal optimizer, one of its drawbacks focuses on its performance dependency on its parameters, which differ from one problem to another. In ALA-PSO, each particle is viewed as an intelligent agent and aim at improve itself performance, and can autonomously learn how to tune its parameters from its own experiment of successes and failures. For each particle, it means success movement if the value of objective function in current position is improved than previous position, otherwise means failure. In case of successful movement, the parameters that are positive correlation with the direction of forward movement should be increased otherwise should be decreased. Meanwhile, in case of unsuccessful movement, inverse operation should be performed. The proposed parameter adaptive method is compared with several existing adaptive strategies, and the results show that ALA-PSO is not only effective, but also robust in different categories benchmarks.

P109 *A Growing Partitional Clustering Based on Particle Swarm Optimization [#E-14769]*

Nuosi Wu, Zexuan Zhu and Zhen Ji, Shenzhen University, China

This paper proposes a growing partitional clustering method based on particle swarm optimization (PSO) namely PSOGC for handling data with non-spherical or non-linearly separable distribution. Particularly, PSOGC uses PSO to optimize the cluster centers. In each iteration of PSO, the particles encoding candidate cluster centers are evolved according to their social and personal knowledge. Given the candidate cluster centers, a growing strategy increasingly absorbs nearby data samples into the corresponding cluster based on k-nearest neighbor graph. The fitness of each particle is evaluated in terms of intra-cluster connectivity and inter-cluster disconnectivity of the resultant clustering. The combination of PSO and growing strategy ensures the stability of global search and the robustness of partition on data of different non-spherical shapes. Experimental results on six synthetic and three UCI real-world data sets demonstrate the efficiency of PSOGC.

P110 *A Novel Chaotic Artificial Bee Colony Algorithm Based on Tent Map [#E-14136]*

Fangjun Kuang, Zhong Jin, Weihong Xu and Siyang Zhang, Nanjing University of Science and Technology, China; Hunan Vocational Institute of Safety and Technology, China

A novel self-adaptive chaotic artificial bee colony algorithm based on Tent map (STOC-ABC) is proposed to enhance the global convergence and the population diversity. In the STOC-ABC, Tent chaotic opposition-based learning initialization method is presented to diversify the initial individuals and obtain good initial solutions. Furthermore, the self-adaptive Tent chaotic searching is implemented at the zones nearby individual optimum solution to help the artificial bee colony (ABC) algorithm to escape from the local optimum effectively. Moreover, the tournament selection strategy in onlooker bee phase is employed to increase the ability of the algorithm and avoid premature convergence. Experiments on six complex benchmark functions with high-dimension, the results further demonstrate that, the STOC-ABC not only accelerates the convergence rate and improves solution precision, but also provides excellent performance in dealing with complex high-dimensional functions.

P111 *A Novel Artificial Bee Colony Algorithm with Integration of Extremal Optimization for Numerical Optimization Problems [#E-14143]*

Min-Rong Chen, Wei Zeng, Guo-Qiang Zeng, Xia Li and Jian-Ping Luo, Shenzhen University, China

Artificial Bee Colony (ABC) algorithm is an optimization algorithm based on a particular intelligent behaviour of honeybee swarms. The standard artificial bee algorithm is weak at the locally searching capability and precision. Extremal Optimization (EO) is a general-purpose heuristic method which has strong local- search capability and has been successfully applied to a wide variety of hard optimization problems. In order to strengthen the local-search capability of ABC, this work proposes a novel hybrid algorithm, called ABC-EO algorithm, through introducing EO to ABC. The simulation results show that the performance of the proposed algorithm is superior to those of the state-of-the-art algorithms in complex numerical optimization problems.

P112 *Hybrid ACO/EA Algorithms Applied to the Multi-Agent Patrolling Problem [#E-14138]*

Fabrice Lauri and Abder Koukam, IRTES-SeT, France

Patrolling an environment consists in visiting as frequently as possible its most relevant areas in order to supervise, control or protect it. This task is commonly performed by a team of agents that need to coordinate their actions for achieving optimal performance. We address here the problem of multi-agent patrolling in known environments where agents may move at different speeds and visit priorities on some areas may be specified. Two classes of patrolling strategies are studied: the single-cycle strategies and the partition-based strategies. Several single-core and multi-core variants of a template state-of-the-art hybrid algorithm are proposed for generating partition-based strategies. These are experimentally compared with a state-of-the-art heuristic-based algorithm generating single-cycle strategies. Experimental results show that: the heuristic-based algorithm only generates efficient strategies when agents move at the same speeds and no visit priorities have been defined; all single-core variants are equivalent; multi-core hybrid algorithms may improve overall quality or reduce variance of the solutions obtained by single-core algorithms.

P113 *Comparison of Multiobjective Particle Swarm Optimization and Evolutionary Algorithms for Optimal Reactive Power Dispatch Problem [#E-14093]*

Yujiao Zeng and Yanguang Sun, Automation Research and Design Institute of Metallurgical Industry, China

The optimal reactive power dispatch (ORPD) problem is formulated as a complex multiobjective optimization problem, involving nonlinear functions, continuous and discrete variables and various constraints. Recently, multiobjective evolutionary algorithms (MOEAs) and multiobjective particle swarm optimization (MOPSO) have received a growing interest in solving the multiobjective optimization problems. In this paper, MOPSO, and two highly competitive algorithms of MOEAs, that is, nondominated sorting genetic algorithm II (NSGA- II) and strength Pareto evolutionary algorithm (SPEA2) are presented for solving the ORPD problem. Moreover, a mixed-variable handling method and an effective constraint handling approach are employed to deal with various types of variables and constraints. The proposed algorithms are evaluated on the standard IEEE 30-bus and 118-bus test systems. In addition, several multiobjective performance metrics are employed to compare these algorithms with respect to convergence, diversity, and computational efficiency. The results show the effectiveness of MOEAs and MOPSO for solving the ORPD problem. Furthermore, the comparison results indicate that MOPSO generally outperforms other algorithms for ORPD and has a great potential in dealing with large-scale optimal power flow problems.

P114 *MOPSOhv: A New Hypervolume-Based Multi-Objective Particle Swarm Optimizer [#E-14657]*

Ivan Chaman-Garcia, Carlos A. Coello Coello and Alfredo Arias-Montano, CINVESTAV-IPN, Mexico; IPN-ESIME Unidad Ticoman, Mexico

This paper proposes a new hypervolume-based multi-objective particle swarm optimizer (called MOPSOhv) that uses an external archive to store the global nondominated solutions found during the evolutionary process. The proposed algorithm makes use of the hypervolume contribution of archived solutions for selecting global and personal leaders for each particle in the main swarm, and also as a mechanism for pruning the external archive when it is updated with new nondominated solutions. In order to increase the diversity when particles are updated in their positions, a mutation operator is used. The performance of the proposed algorithm is evaluated adopting standard test problems and indicators reported in the specialized literature, comparing its results with respect to those obtained by state-of-the-art multi-objective evolutionary algorithms. Our preliminary results indicate that our proposal is competitive with respect to state-of-the-art multi-objective evolutionary algorithms, being particularly suitable for solving many-objective optimization problems (i.e., problems having more than 3 objectives).

P115 *A Population Diversity Maintaining Strategy Based on Dynamic Environment Evolutionary Model for Dynamic Multiobjective Optimization [#E-14110]*

Zhou Peng, Jinhua Zheng and Juan Zou, Xiangtan University, China

Maintaining population diversity is a crucial issue for the performance of dynamic multiobjective optimization algorithms. However traditional dynamic multiobjective evolutionary algorithms usually imitate the biological evolution of their own, maintain population diversity through different strategies and make the population be able to track the Pareto optimal solution set after the change efficiently. Nevertheless, these algorithms neglect the role of dynamic environment in evolution, lead to the lacking of active and instructional search. In this paper, a population diversity maintaining strategy based on dynamic environment evolutionary model is proposed (DEE-PDMS). This strategy builds a dynamic environment evolutionary model when a change is detected, which makes use of the dynamic environment to record the different knowledge and information generated by population before and after environmental change, and in turn the knowledge and information guide the search in new environment. The model enhances population diversity by guided fashion, makes the simultaneous evolution of the environment and population. A comparison study with other two state-of-the-art strategies on five test problems with linear or nonlinear correlation between design variables has shown the effectiveness of the DEE-PDMS for dealing with dynamic environments.

P116 *Multi-Objective Flexible Job-Shop Scheduling Problem with DIPSO: More Diversity, Greater Efficiency [#E-14146]*

Luiz Carvalho and Marcia Fernandes, Federal University of Uberlandia, Brazil

The Flexible Job Shop Problem is one of the most important NP-hard combinatorial optimization problems. Evolutionary computation has been widely used in research concerning this problem due to its ability for dealing with large search spaces and the possibility to optimize multiple objectives. Particle Swarm Optimization has presented good results but the algorithms based on this technique have premature convergence, therefore some proposals introduce genetic operators or other local search methods in order to avoid the local minimum. Therefore, this paper presents a hybrid and multi-objective algorithm, Particle Swarm Optimization with Diversity (DIPSO), based on Particle Swarm Optimization along with the genetic operators and Fast Non-dominated Sorting. Thus, to maintain a high degree of diversity in order to guide the search for a better solution while ensuring convergence, a new crossover operator is introduced. The efficiency of this operator is tested in relation to the proposed objectives by using typical examples from the literature. The results are compared to other studies that have had good results by means some Evolutionary Computation technique as for instance MOEAGLS, MOGA, PSO + SA and PSO + TS.

P117 *Calculating the Complete Pareto Front for a Special Class of Continuous Multi-Objective Optimization Problems [#E-14167]*

Xiao-Bing Hu, Ming Wang and Mark S Leeson, Beijing Normal University, China; University of Warwick, United Kingdom

Existing methods for multi-objective optimization usually provide only an approximation of a Pareto front, and there is little theoretical guarantee of finding the real Pareto front. This paper is concerned with the possibility of fully determining the true Pareto front for those continuous multi-objective optimization problems for which there are a finite number of local optima in terms of each single objective function and there is an effective method to find all such local optima. To this end, some generalized theoretical conditions are firstly given to guarantee a complete cover of the actual Pareto front for both discrete and continuous problems. Then based on such conditions, an effective search procedure inspired by the rising sea level phenomenon is proposed particularly for continuous problems of the concerned class. Even for general continuous problems to which not all local optima are available, the new method may still work well to approximate the true Pareto front. The good practicability of the proposed method is especially underpinned by multi-optima evolutionary algorithms. The advantages of the proposed method in terms of both solution quality and computational efficiency are illustrated by the simulation results.

P118 *A Self-Adaptive Evolutionary Approach to the Evolution of Aesthetic Maps for a RTS Game [#E-14695]*

Raul Lara-Cabrera, Carlos Cotta and Antonio J. Fernandez-Leiva, University of Malaga, Spain

Procedural content generation (PCG) is a research field on the rise, with numerous papers devoted to this topic. This paper presents a PCG method based on a self-adaptive evolution strategy for the automatic generation of maps for the real-time strategy (RTS) game Planet Wars. These maps are generated in order to fulfill the aesthetic preferences of the user, as implied by her assessment of a collection of maps used as training set. A topological approach is used for the characterization of the maps and their subsequent evaluation: the sphere-of-influence graph (SIG) of each map is built, several graph-theoretic measures are computed on it, and a feature selection method is utilized to determine adequate subsets of measures to capture the class of the map. A multiobjective evolutionary algorithm is subsequently employed to evolve maps, using these feature sets in order to measure distance to good (aesthetic) and bad (non-aesthetic) maps in the training set. The so-obtained results are visually analyzed and compared to the target maps using a Kohonen network.

P119 *Enhanced Differential Evolution with Adaptive Direction Information [#E-14020]*

Yiqiao Cai and Jixiang Du, Huaqiao University, China

Most recently, a DE framework with neighborhood and direction information (NDi- DE) was proposed to exploit the information of population and was demonstrated to be effective for most of the DE variants. However, the performance of NDi-DE heavily depends on the selection of direction information. In order to alleviate this problem, two adaptive operator selection (AOS) mechanisms are introduced to adaptively select the most suitable type of direction information for the specific mutation strategy during the evolutionary process. The new method is named as adaptive direction information based NDi-DE (aNDi-DE). In this way, the good balance between exploration and exploitation can be dynamically achieved. To evaluate the effectiveness of aNDi-DE, the proposed method is applied to the well-known DE/rand/1 algorithm. Through the experimental study, we show that aNDi-DE can effectively improve the efficiency and robustness of NDi-DE.

P120 *Visualizing the Population of Meta-Heuristics During the Optimization Process Using Self-Organizing Maps [#E-14104]*

Marcelo Lotif, University of Fortaleza (UNIFOR), Brazil

This study proposes a novel Visual Data Mining technique based on Self-Organizing Maps (SOM) to visualize the population points of metaheuristic algorithms while they execute their search process. The SOM is used to divide the search space of the optimization function into bi-dimensional regions, allowing one to perform a visual analysis by mapping the points into the 2-dimensional space, in order to compare various executions of the functions performed with different parameter configurations. The use of these maps as a Visual Data Mining tool aims to visually process the resulting data and identify behavioral patterns of the meta- heuristic instances.

P121 *Self-Adaptive Morphable Model Based Multi-View Non-Cooperative 3D Face Reconstruction [#E-14137]*

Kuicheng Lin, Xue Wang, Xuanping Li and Yuqi Tan, Tsinghua University, China

Non-cooperative 3D face reconstruction is very significant in the area of intelligent security. According to non-cooperative 3D face reconstruction, the non-complete information fusion of multi-view face images can be realized to get a more complete face. This paper proposes a non-cooperative 3D face reconstruction method. A multimedia sensor network is employed to detect a person and get face images from different views. View-based active appearance models (View-based AAM) then helps to extract feature points and estimate probable pose angle. A new self-adaptive 3D morphable model based multi-view face geometry reconstruction method is designed to generate a 3D face model with particle swarm optimization (PSO). As the initial pose estimation is not accurate, particle swarm optimization is also used to regulate pose estimation results for optimizing 3D reconstruction result. "Mirror" strategy is employed to difine the invisible part of the face based on the mirror image of the visible part for texture mapping. Experiments have shown that the proposed method can achieve the non-cooperative 3D reconstruction efficaciously.

P122 *Using Electromagnetic Algorithm for Tuning the Structure and Parameters of Neural Networks [#E-14153]*

Ayad Turky and Salwani Abdullah, Universiti Kebangsaan Malaysia, Malaysia

Electromagnetic algorithm is a population based meta-heuristic which imitates the attraction and repulsion of sample points. In this paper, we propose an electromagnetic algorithm to simultaneously tune the structure

and parameter of the feed forward neural network. Each solution in the electromagnetic algorithm contains both the design structure and the parameters values of the neural network. This solution later will be used by the neural network to represents its configuration. The classification accuracy returned by the neural network represents the quality of the solution. The performance of the proposed method is verified by using the well-known classification benchmarks and compared against the latest methodologies in the literature. Empirical results demonstrate that the proposed algorithm is able to obtain competitive results, when compared to the best-known results in the literature.

P123 *Feature Selection Based on Manifold-Learning with Dynamic Constraint-Handling Differential Evolution [#E-14595]*

Zhihui Li, Zhigang Shang, Jane Jing Liang and Boyang Qu, Zhengzhou univerisity, China; Zhongyuan University of Technology, China

Feature Selection in high dimensional feature space is the main challenge in statistic learning field. In this paper, a novel feature selection method based on manifold learning is proposed. The distance metric weight vector are optimized to maximize the multi-class margin in the manifold embedded in low dimension space, as well as minimize its L1-norm. This multi objectives optimization problem is solved by a Differential Evolution (DE) with dynamic constraint -handling mechanism. And a criterion to determine the best feature subset based on the optimal weight vector is given. The test result for selecting the optimal feature subset of UCI breast tissue dataset indicates that this real coded feature selection method could find some feature subset which has good classification robustness.

P124 *Metaheuristics for the 3D Bin Packing Problem in the Steel Industry [#E-14611]*

Joaquim Viegas, Susana Vieira, Joao M. Sousa and Elsa Henriques, Universidade de Lisboa, Portugal

This work presents heuristic and metaheuristic approaches for addressing the real-world steel cutting problem of a retail steel distributor as a cutting and packing problem. It consists on the cutting of large steel blocks in order to obtain smaller pieces ordered by clients. The problem was formulated as a 3-dimensional residual bin packing problem for minimization of scrap generation, with guillotine cutting constraint and chips scrap generation. A tabu search and best-fit decreasing (BFD) approaches are proposed and their performance compared to an heuristic and ant colony optimization (ACO) algorithms. It's shown that the tabu search and best-fit decreasing algorithm are able to reduce the generated scrap by up to 52% in comparison with the heuristic. The orders to suppliers were also reduced by up to 35%. The analysis of the results of the different approaches provide insight onto the most important factors in the problem's scrap minimization.

P125 *A New CSP Graph-Based Representation to Resource-Constrained Project Scheduling Problem [#E-14663]*

Antonio Gonzalez-Pardo and David Camacho, Universidad Autonoma de Madrid, Spain

Resource-Constrained Project Scheduling Problem (RCPSP) is a NP-hard combinatorial problem that consists in scheduling different activities in such a way the resource, precedence, and temporal constraints are satisfied. The main problem when dealing with NP-hard problems is the exponential growth of the computational resources needed to solve the problems. This work is an extension of a previous one, where a new CSP graph-based representation to solve Constraint Satisfaction Problems (CSP) by using Ant Colony Optimization (ACO) were proposed. This paper studies the behaviour of the CSP graph-based representation when it is applied to a real-world complex problem, in this case the RCPSP. The dataset used in this work has been extracted from Project Scheduling Problem Library (PSPLIB). Experimental results show that the proposed approach provides excellent results, closer to the optimum values published in the PSPLIB repository. Also, it has been analysed how the number of jobs and the number of different execution modes affect the performance of the algorithm.

P126 *Optimization Algorithm for Rectangle Packing Problem Based on Varied-Factor Genetic Algorithm and Lowest Front-Line Strategy [#E-14724]*

Haiming Liu, Jiong Zhou, Xinsheng Wu and Peng Yuan, South China University of Technology, China

Rectangle packing problem exists widely in manufacturing processes of modern industry, such as cutting of wood, leather, metal and paper, etc. It is also known as a typical NP-Complete combinatorial optimization problem with geometric nature, which contains two sub-problems, parking problem and sequencing problem of rectangles. Considering the features of the problem, this paper proposes an optimization algorithm based on an improved genetic algorithm (GA), combined with a lowest front-line strategy for parking rectangles on the sheet. The genetic algorithm is introduced to determine packing sequence of rectangles. To avoid premature convergence or falling into local optima, the traditional GA is improved by changing genetic factors according to quality of solutions obtained during evolution. Numerical experiments were conducted to take an evaluation for the proposed algorithm, along with a comparison with another algorithm. The simulation results show that the proposed algorithm has better performance in optimization results and can improve utilization rate of material effectively.

P127 *A Parallel Evolutionary Solution for the Inverse Kinematics of Generic Robotic Manipulators [#E-14771]*

Siavash Farzan and Guilherme DeSouza, University of Missouri, United States

This paper is an improvement of our previous work. It provides a robust, fast and accurate solution for the inverse kinematics problem of generic serial manipulators - i.e. any number and any combination of revolute and prismatic joints. Here, we propose further enhancements by applying an evolutionary approach on the previous architecture and explore the effects of different parameters on the performance of the algorithm. The algorithm only requires the Denavit-Hartenberg (D-H) representation of the robot as input and no training or robot-dependent optimization function is needed. In order to handle singularities and to overcome the possibility of multiple paths in redundant robots, our approach relies on the computation of multiple (parallel) numerical estimations of the inverse Jacobian while it selects the current best path to the desired configuration of the end-effector using an evolutionary algorithm. But unlike other iterative methods, our method achieves submillimeter accuracy in 20 iterations in average. The algorithm was implemented in C/C++ using POSIX threads, and it can be easily expanded to use more threads and/or many-core GPUs. We demonstrate the high accuracy and real-time performance of our method by testing it with five different robots including a 7-DoF redundant robot. Results show that the evolutionary implementation of the algorithm is able to reduce the number of iterations compared to the previous method significantly, while also finding the solution within the specified margin of error.

P128 *Feature Extraction Based on Trimmed Complex Network Representation for Metabolomic Data Classification [#E-14778]*

Yue Chen, Zexuan Zhu and Zhen Ji, Shenzhen University, China

Over the last few decades, metabolomics has been widely used to reveal the linkages between metabolite signal levels and physiological states. Metabolomic data are naturally high dimensional and noisy, which poses computational challenges for data analysis. In this study, a novel feature extraction method based on trimmed complex network representation is proposed for metabolomic data classification. Particularly, the proposed method begins with feature selection on the original data, and then a complex network of the selected features is constructed to represent each data sample. Afterward, the network edges are trimmed and a few topological network metrics are extracted as new features for the classification of the samples. The experimental results on a real-world metabolomic data of clinical liver transplantation demonstrate the efficiency of the proposed feature extraction method.

P129 *Primary Study on Feedback Controlled Differential Evolution [#E-14783]*
Kenichi Tamura and Keiichiro Yasuda, Tokyo Metropolitan University, Japan

The primary study on feedback controlled Differential Evolution (FCDE) is presented. FCDE is a novel framework of DE with an automatic parameter adjustment mechanism, which controls its search situation (evaluation index) to be a promising situation (reference index) by the error feedback. Its adjustment mechanism consists of three parts: Estimator, Referencer, and Controller. Estimator calculates an evaluation index which quantitatively measures the search situation about the population diversity. Referencer generates a reference index being the ideal target of the evaluation index. Controller operates the DE parameters every generation to make the evaluation index follow the reference index. Further, this paper actually realizes a FCDE method using a typical DE by designing the three parts. The effectiveness of the proposed method is confirmed through computational experiment from viewpoint of the controllability and performance.

P130 *A Route Planning Strategy for the Automatic Garment Cutter Based on Genetic Algorithm [#E-14428]*
Wenchao Yu and Linji Lu, Shanghai Jiao Tong University, China

This paper proposes a route planning algorithm for the automatic garment cutter, a machine extensively used in the clothing industry, aiming at reducing the length and improving the smoothness of quick moving route for the cutter. With proper constraints for the cloth segments and knife-down points, the route planning problem is resolved into a generalized travelling salesman problem (GTSP) of the first category, for which an enhanced genetic algorithm is proposed. In this paper, we firstly outline the procedure of the algorithm and discuss some important details, including individual fitness calculation based on the multistage graph problem, a local search algorithm with 2-opt method, etc. Then a position-reservation crossover operator based on dual-relevancy, and an adaptive mutation operator based on population dispersion are proposed, which can accelerate convergence of the algorithm as well as prevent locking into local minima as much as possible. Finally, experimental tests are performed on the GTSP Instances Library and the data of garment CAD files, which demonstrates the effectiveness of our route planning strategy in terms of both solution quality and running time.

Monday, July 7, 4:00PM-6:00PM

Special Session: MoE2-1 Evolutionary Multi-Objective Optimization and Decision Making

Monday, July 7, 4:00PM-6:00PM, Room: 203A, Chair: Sanaz Mostaghim

4:00PM *Comparative Analysis of Classical Multi-Objective Evolutionary Algorithms and Seeding Strategies for Pairwise Testing of Software Product Lines [#E-14526]*
Roberto Erick Lopez-Herrejon, Javier Ferrer, Francisco Chicano, Alexander Egyed and Enrique Alba, Johannes Kepler University Linz, Austria; University of Malaga, Spain

Software Product Lines (SPLs) are families of related software products, each with its own set of feature combinations. Their commonly large number of products poses a unique set of challenges for software testing as it might not be technologically or economically feasible to test of all them individually. SPL pairwise testing aims at selecting a set of products to test such that all possible combinations of two features are covered by at least one selected product. Most approaches for SPL pairwise testing have focused on achieving full coverage of all pairwise feature combinations with the minimum number of products to test. Though useful in many contexts, this single-objective perspective does not reflect the prevailing scenario where software engineers face trade-offs between maximizing coverage or minimizing the number of products to test. In contrast, our work is the first to propose a classical multi-objective formalisation where both objectives are equally important. We study the application to SPL pairwise testing of four classical multi-objective evolutionary algorithms. We developed three seeding strategies - techniques that leverage problem domain knowledge - and measured their performance impact on a large and diverse corpus of case studies using two well-known multi- objective quality metrics. Our study identifies performance differences among the algorithms and corroborates that the more domain knowledge leveraged the better the search results. Our findings enable software engineers to select not just one solution (like single-objective techniques) but instead to select from an array of test suite possibilities the one that best matches the economical and technological constraints of their testing context.

4:20PM *An MOEA/D with Multiple Differential Evolution Mutation Operators [#E-14255]*
Yang Li, Aimin Zhou and Guixu Zhang, East China Normal University, China

In evolutionary algorithms, the reproduction operators play an important role. It is arguable that different operators may be suitable for different kinds of problems. Therefore, it is natural to combine multiple operators to achieve better performance. To demonstrate this idea, in this paper, we propose an MOEA/D with multiple differential evolution mutation operators called MOEA/D-MO. MOEA/D aims to decompose a multiobjective optimization problem (MOP) into a number of single objective optimization problems (SOPs) and optimize those SOPs simultaneously. In MOEA/D-MO, we combine multiple operators to do reproduction. Three mutation strategies with randomly selected parameters from a parameter pool are used to generate new trial solutions. The proposed algorithm is applied to a set of test instances with different complexities and characteristics. Experimental results show that the proposed combining method is promising.

4:40PM *Multi-Objective Transportation Network Design: Accelerating Search by Applying e-NSGAII [#E-14546]*
Ties Brands, Luc Wismans and Eric van Berkum, University of Twente, Netherlands; DAT.Mobility, Netherlands

The optimization of infrastructure planning in a multimodal passenger transportation network is formulated as a multi-objective network design problem, with accessibility, use of urban space by parking, operating deficit and climate impact as objectives. Decision variables are the location of park and ride facilities, train stations and the frequency of public transport lines. For a real life case study the Pareto set is estimated by the Epsilon Non-dominated Sorting Genetic Algorithm (e-NSGAII), since due to high computation time a high performance within a limited number of evaluated solutions is desired. As a benchmark, the NSGAII is used. In this paper Pareto sets from runs of both algorithms are analyzed and compared. The results show that after a reasonable computation time, e-NSGAII outperforms

NSGAII for the most important indicators, especially in the early stages of algorithm executions.

5:00PM *A Comparison of Multi-Objective Evolutionary Algorithms for the Ontology Meta-Matching Problem [#E-14664]*

Giovanni Acampora, Hisao Ishibuchi and Autilia Vitiello, Nottingham Trent University, United Kingdom; Osaka Prefecture University, Japan; University of Salerno, Italy

In recent years, several ontology-based systems have been developed for data integration purposes. The principal task of these systems is to accomplish an ontology alignment process capable of matching two ontologies used for modelling heterogeneous data sources. Unfortunately, in order to perform an efficient ontology alignment, it is necessary to address a nested issue known as ontology meta-matching problem consisting in appropriately setting some regulating parameters. Over years, evolutionary algorithms are appeared to be the most suitable methodology to address this problem. However, almost all of existing approaches work with a single function to be optimized even though a possible solution for the ontology meta-matching problem can be viewed as a compromise among different objectives. Therefore, approaches based on multi objective optimisation are emerging as techniques more efficient than conventional evolutionary algorithms in solving the meta-matching problem. The aim of this paper is to perform a systematic comparison among well-known multi-objective Evolutionary Algorithms (EAs) in solving the meta-matching problem. As shown through computational experiments, among the compared multi-objective EAs, OMOPSO statistically provides the best performance in terms of the well-known measures such as hypervolume, index and coverage of two sets.

5:20PM *Integrating User Preferences and Decomposition Methods for Many-Objective Optimization [#E-14752]*

Asad Mohammadi, Mohammad Nabi Omidvar, Xiaodong Li and Kalyanmoy Deb, RMIT University, Australia; Michigan State University, United States

Evolutionary algorithms that rely on dominance ranking often suffer from a low selection pressure problem when dealing with many-objective problems. Decomposition and user- preference based methods can help to alleviate this problem to a great extent. In this paper, a user-preference based evolutionary multi-objective algorithm is proposed that uses decomposition methods for solving many-objective problems. Decomposition techniques that are widely used in multi-objective evolutionary optimization require a set of evenly distributed weight vectors to generate a diverse set of solutions on the Pareto-optimal front. The newly proposed algorithm, R-MEAD2, improves the scalability of its previous version, R-MEAD, which uses a simplex- lattice design method for generating weight vectors. This makes the population size is dependent on the dimension size of the objective space. R-MEAD2 uses a uniform random number generator to remove the coupling between dimension and the population size. This paper shows that a uniform random number generator is simple and able to generate evenly distributed points in a high dimensional space. Our comparative study shows that R-MEAD2 outperforms the dominance-based method R-NSGA-II on many-objective problems.

5:40PM *A Multi-Objective Evolutionary Algorithm Based on Decomposition for Constrained Multi-Objective Optimization [#E-14848]*

Saul Zapotecas Martinez and Carlos A. Coello Coello, Shinshu University, Japan; CINVESTAV-IPN, Mexico

In spite of the popularity of the Multi-objective Evolutionary Algorithm based on Decomposition (MOEA/D), its use in Constrained Multi-objective Optimization Problems (CMOPs) has not been fully explored. In the last few years, there have been a few proposals to extend MOEA/D to the solution of CMOPs. However, most of these proposals have adopted selection mechanisms based on penalty functions. In this paper, we present a novel selection mechanism based on the well-known epsilon-constraint method. The proposed approach uses information related to the neighborhood adopted in MOEA/D in order to obtain solutions which minimize the objective functions within the allowed feasible region. Our preliminary results indicate that our approach is highly competitive with respect to a state-of-the-art MOEA which solves in an efficient way the constrained test problems adopted in our comparative study.

Special Session: MoE2-2 Differential Evolution: Past, Present and Future

Monday, July 7, 4:00PM-6:00PM, Room: 203B, Chair: Kai Qin

4:00PM *Cooperative DynDE for Temporal Data Clustering [#E-14261]*

Kristina S. Georgieva and Andries Engelbrecht, University of Pretoria, South Africa

Temporal data is common in real-world datasets. Clustering of such data allows for relationships between data patterns over time to be discovered. Differential evolution (DE) algorithms have previously been used to cluster temporal data. This paper proposes the cooperative data clustering dynamic DE algorithm (CDCDynDE), which is an adaptation to the data clustering dynamic DE (DCDynDE) algorithm where each population searches for a single cluster centroid. The paper applies the proposed algorithm to a variety of temporal datasets with different frequencies of change, severities of change, dataset dimensions and data migration types. The clustering results of the cooperative data clustering DynDE are compared against the original data clustering DynDE, the re-initialising data clustering DE and the standard data clustering DE. A statistical analysis of these results shows that the cooperative data clustering DynDE algorithm obtains better data clustering solutions to the other three algorithms despite changes in frequency, severity, dimension and data migration types.

4:20PM *Multi-Objective Differential Evolution Algorithm Based on Fast Sorting and a Novel Constraints Handling Technique [#E-14627]*

Jane Jing Liang, B. Zheng, Boyang Qu and H. Song, Zhengzhou University, China; Zhongyuan University of Technology, China

In this paper, an improved multi-objective differential evolution algorithm is proposed to solve constraints in multi-objective optimization. Research has shown that the information of infeasible solutions is also important and can help the algorithm improve the convergence and diversity of solutions. A novel constraint handling method is introduced to ensure that a certain number of good infeasible solutions will be kept in the procedure of evolution to guide the search of the individuals. The proposed method is compared with two other constrained multi-objective differential evolution algorithms and the results show that the proposed method is competitive.

4:40PM *A Mutation and Crossover Adaptation Mechanism for Differential Evolution Algorithm [#E-14642]*

Johanna Aalto and Jouni Lampinen, University of Vaasa, Finland

A new adaptive Differential Evolution algorithm called EWMA-DECrF is proposed. In original Differential Evolution algorithm three different control parameter values must be pre-specified by the user a priori; Population size, crossover and mutation scale factor. Choosing good parameters can be very difficult for the user, especially for the practitioners. In the proposed algorithm the mutation scale factor and crossover factor is adapted using a mechanism based on exponential weighting moving average, while the population size is kept fixed as in standard Differential Evolution. The algorithm was evaluated by using the set of 25 benchmark functions provided by CEC2005 special session on real-parameter optimization. It was compared to standard DE/rand/1/bin version and the two other algorithms also based on exponential weighting moving average; EWMA-DE and EWMA- DECr. Results show that proposed algorithm EWMA-DECrF outperformed the other algorithms by its average ranking based on normalized success performance.

5:00PM *An Analysis of the Automatic Adaptation of the Crossover Rate in Differential Evolution [#E-14734]*

Carlos Segura, Carlos A. Coello Coello, Eduardo Segredo and Coromoto Leon, CINVESTAV-IPN, Mexico; Universidad de La Laguna, Spain

Differential Evolution (DE) is a very efficient metaheuristic for optimization over continuous spaces which has gained much popularity in recent years. Several parameter control strategies have been proposed to automatically adapt its internal parameters. The most advanced DE variants take into account the feedback obtained in the optimization process to guide the dynamic setting of the DE parameters. Indeed, the automatic adaptation of the crossover rate (CR) has attracted a lot of research in the last decades. In most of such strategies, the quality of using a given CR value is measured by considering the probability of performing a replacement in the DE selection stage when such a value is applied. One of the main contributions of this paper is to experimentally show that the probability of replacement induced by the application of a given CR value and the quality of the obtained results are not as correlated as expected. This might cause a performance deterioration that avoids the achievement of good quality solutions even in the long-term. In addition, the experimental evaluation developed with a set of optimization problems of varying complexities clarifies some of the advantages and drawbacks of the different tested strategies. The only component varied among the different tested schemes has been the CR control strategy. The study presented in this paper provides advances in the understanding of the inner working of several state-of-the-art adaptive DE variants.

5:20PM *Self-Adaptive Differential Evolution with Local Search Chains for Real-Parameter Single-Objective Optimization [#E-14836]*

A. K. Qin, Ke Tang, Hong Pan and Siyu Xia, RMIT University, Australia; University of Science and Technology of China, China; Southeast University, China

Differential evolution (DE), as a very powerful population-based stochastic optimizer, is one of the most active research topics in the field of evolutionary computation. Self-adaptive differential evolution (SaDE) is a well- known DE variant, which aims to relieve the practical difficulty faced by DE in selecting among many candidates the most effective search strategy and its associated parameters. SaDE operates with multiple candidate strategies and gradually adapts the employed strategy and its accompanying parameter setting via learning the preceding behavior of already applied strategies and their associated parameter settings. Although highly effective, SaDE concentrates more on exploration than exploitation. To enhance SaDE's exploitation capability while maintaining its exploration power, we incorporate local search chains into SaDE following two different paradigms (Lamarckian and Baldwinian) that differ in the ways of utilizing local search results in SaDE. Our experiments are conducted on the CEC-2014 real-parameter single-objective optimization testbed. The statistical comparison results demonstrate that SaDE with Baldwinian local search chains, armed with suitable parameter settings, can significantly outperform original SaDE as well as classic DE at any tested problem dimensionality.

5:40PM *Trading-Off Simulation Fidelity and Optimization Accuracy in Air-Traffic Experiments using Differential Evolution [#E-14710]*

Rubai Amin, Jiangjun Tang, Mohamed Ellejmi, Stephen Kirby and Hussein Abbass, University of New South Wales, Australia; Eurocontrol Experimental Centre, France

Black-box optimization relies in many engineering applications on the use of a simulation to obtain a numeric evaluation or a score for a proposed solution. In these cases, the cost of optimization is mostly a reflection of the cost of running this simulation environment. On the one hand, the higher fidelity the simulation environment is, the longer it is likely to take to evaluate a single solution. Consequently, less solutions are allowed to be evaluated given a time constraint on the running time of the optimization algorithm. On the other hand, the less fidelity the simulation environment is, the more likely more solutions could be evaluated within the same time constraint. However, the relationship between fidelity and the quality of the final solution obtained by the optimization is largely unexplored area of research. In this paper, we present an approach for adjusting taskload of Air traffic controllers (ATC) in real time by using three different shadow simulators of increasing fidelity and Differential Evolution (DE) as the evolutionary optimization algorithm. According to air traffic conditions, DE optimizes a goal programming model to steer the taskload up or down towards a predefined taskload target by generating two ATC requests every 10 minutes. The experiment results suggest demonstrates how a high fidelity simulator can help DE to achieve better results in the absence of any time constraint on running the experiments. However, when there is a tight time constraint is imposed, low fidelity simulators allow DE to explore more solutions in the search space by cutting down on the extra time needed when high fidelity simulators are used.

Special Session: MoE2-3 Evolutionary Computation in Combinatorial Optimization

Monday, July 7, 4:00PM-6:00PM, Room: 203C, Chair: Rong Qu

4:00PM *A Hybrid Discrete Particle Swarm Optimisation Method for Grid Computation Scheduling [#E-14866]*

Stephen Bennett, Su Nguyen and Mengjie Zhang, Victoria University of Wellington, New Zealand

Allocating jobs to heterogeneous machines in grid systems is an important task in computational grid to effectively utilise computational resources. Particle swarm optimisation (PSO) has been recently applied to grid computation scheduling (GCS) problems and shown very promising results as compared to other meta-heuristics in the literature. However, PSO with the traditional position updating mechanism still has problems coping with the discrete nature of GCS. This paper proposed a new updating mechanism for discrete PSO that directly utilise discrete solutions from personal and global best particles. A new local search heuristic has also been proposed to refine solutions found by PSO. The results show that the hybrid PSO is more effective than other existing PSO methods in the literature when tested on two benchmark datasets. The hybrid method is also very efficient, which makes it suitable to deal with large-scale problem instances.

4:20PM *A Combinatorial Algorithm for the Cardinality Constrained Portfolio Optimization Problem [#E-14295]*

Tianxiang Cui, Shi Cheng and Ruibin Bai, The University of Nottingham, China

Portfolio optimization is an important problem based on the modern portfolio theory (MPT) in the finance field. The idea is to maximize the portfolio expected return as well as minimizing portfolio risk at the same time. In this work, we propose a combinatorial algorithm for the portfolio optimization problem with the cardinality and bounding constraints. The proposed algorithm hybridizes a metaheuristic approach (particle swarm optimization, PSO) and a mathematical programming method where PSO is used to deal with the cardinality constraints and the math programming method is used to deal with the rest of the model. Computational results are given for the benchmark datasets from the OR-library and they indicate that it is a useful strategy for this problem. We also present the solutions obtained by the CPLEX mixed integer program solver for these instances and they can be used as the criteria for the comparison of algorithms for the same problem in the future.

4:40PM *Using Harmony Search with Multiple Pitch Adjustment Operators for the Portfolio Selection Problem [#E-14355]*

Nasser R. Sabar and Graham Kendall, The University of Nottingham Malaysia Campus, Malaysia; The University of Nottingham, United Kingdom

Portfolio selection is an important problem in the financial markets that seeks to distribute an amount of money over a set of assets where the goal is to simultaneously maximize the return and minimize the risk. In this work, we propose a harmony search algorithm (HSA) for this problem. HSA is a population based algorithm that mimics the musician improvisation process in solving optimization problems. At each iteration, HSA generates a new solution using a memory procedure which considers all existing solutions and then perturbs them using a pitch adjustment operator. To deal with different instances, and also changes in the problem landscape, we propose an improved HSA that utilizes multiple pitch adjustment operators. The rationale behind this is that different operators are appropriate for different stages of the search and using multiple operators can enhance the effectiveness of HSA. To evaluate and validate the effectiveness of the proposed HSA, computational experiments are carried out using portfolio selection benchmark instances from the scientific literature. The results demonstrate that the proposed HSA is capable of producing high quality solutions for most of the tested instances when compared with state of the art methods.

5:00PM *Genetic Algorithm with Self-Adaptive Mutation Controlled by Chromosome Similarity [#E-14743]*

Daniel Smullen, Jonathan Gillett, Joseph Heron and Shahryar Rahnamayan, University of Ontario Institute of Technology, Canada

This paper proposes a novel algorithm for solving combinatorial optimization problems using genetic algorithms (GA) with self-adaptive mutation. We selected the N-Queens problem (N between 8 and 32) as our benchmarking test suite, as they are highly multi-modal with huge numbers of global optima. Optimal static mutation probabilities for the traditional GA approach are determined for each N to use as a best-case scenario benchmark in our conducted comparative analysis. Despite an unfair advantage with traditional GA using optimized fixed mutation probabilities, in large problem sizes (where N > 15) multi-objective analysis showed the selfadaptive approach yielded a 100 to 584 percents improvement in the number of distinct solutions generated; the self-adaptive approach also produced the first distinct solution faster than traditional GA with a 1.90 to 70.0 percents speed improvement. Self-adaptive mutation control is valuable because it adjusts the mutation rate based on the problem characteristics and search process stages accordingly. This is not achievable with an optimal constant mutation probability which remains unchanged during the search process.

5:20PM *Chemical Reaction Optimization for the Set Covering Problem [#E-14034]*

James J.Q. Yu, Albert Y.S. Lam and Victor O.K. Li, The University of Hong Kong, Hong Kong; Hong Kong Baptist University, Hong Kong

The set covering problem (SCP) is one of the representative combinatorial optimization problems, having many practical applications. This paper investigates the development of an algorithm to solve SCP by employing chemical reaction optimization (CRO), a general-purpose metaheuristic. It is tested on a wide range of benchmark instances of SCP. The simulation results indicate that this algorithm gives outstanding performance compared with other heuristics and metaheuristics in solving SCP.

5:40PM *Aircraft Landing Problem Using Hybrid Differential Evolution and Simple Descent Algorithm [#E-14072]*

Nasser R. Sabar and Graham Kendall, The University of Nottingham Malaysia Campus, Malaysia; The University of Nottingham, United Kingdom

The aircraft landing problem (ALP) is a practical and challenging optimization problem for the air traffic industry. ALP involves allocating a set of aircrafts to airport runways and allocating landing times for which the goal is to minimize the total cost of landing deviation from the preferred target times. Differential evolution (DE) is a population based algorithm that has been shown to be an effective algorithm for solving continuous optimization problems. However, DE can suffer from slow convergence when utilized for combinatorial optimization problems, thus hindering its ability to return good quality solutions in these domains. To address this we propose a hybrid algorithm that combines differential evolution with a simple descent algorithm. DE is responsible for exploring new regions in the search space, whilst the descent algorithm focuses the search around the area currently being explored. Experimenting with widely used ALP benchmark instances, we demonstrate that the proposed hybrid algorithm performs better than DE without the simple descent algorithm. Furthermore, performance comparisons with other algorithms from the scientific literature demonstrate that our hybrid algorithm performs better, or at least comparably, in terms of both solution quality and computational time.

Special Session: MoE2-4 Artificial Bee Colony Algorithms and their Applications

Monday, July 7, 4:00PM-6:00PM, Room: 203D, Chair: Swagatam Das and M. Fatih Tasgetiren

4:00PM *Search-Evasion Path Planning for Submarines Using the Artificial Bee Colony Algorithm [#E-14008]*

Bai Li, Raymond Chiong and Ligang Gong, Zhejiang University, China; The University of Newcastle, Australia; Beihang University, China

Submarine search-evasion path planning aims to acquire an evading route for a submarine so as to avoid the detection of hostile anti-submarine searchers such as helicopters, aircraft and surface ships. In this paper, we propose a numerical optimization model of search-evasion path planning for invading submarines. We use the Artificial Bee Colony (ABC) algorithm, which has been confirmed to be competitive compared to many other nature-inspired algorithms, to solve this numerical optimization problem. In this work, several search-evasion cases in the two-dimensional plane have been carefully studied, in which the anti-submarine vehicles are equipped with sensors with circular footprints that allow them to detect invading submarines within certain radii. An invading submarine is assumed to be able to acquire the real-time locations of all the anti-submarine searchers in the combat field. Our simulation results show the efficacy of our proposed dynamic route optimization model for the submarine search-evasion path planning mission.

4:20PM *A Bee Colony Algorithm for Routing Guided Automated Battery-Operated Electric Vehicles in Personal Rapid Transit Systems [#E-14464]*

Ezzeddine Fatnassi, Olfa Chebbi and Jouhaina Chaouachi, Tunis University, Tunisia; Carthage University, Tunisia

A personal rapid transit (PRT) system is an on demand transportation service that uses guided automated vehicles. This paper introduces an artificial bee colony (ABC) heuristic for solving the routing problem associated with PRTs. An ABC is a swarm-based heuristic that mimics the behavior of bees. An enhanced version of this algorithm, in which we add a specific method to escape from local optima, is presented in this paper. Experimental results for 1320 randomly generated instances are also presented and analyzed.

4:40PM *A Novel Hybrid Approach for Curriculum Based Course Timetabling Problem [#E-14486]*

Cheng Weng Fong, Hishammuddin Asmuni, Way Shen Lam, Barry McCollum and Paul McMullan, Universiti Teknologi Malaysia, Malaysia; Queen's University Belfast, United Kingdom

This work applies a hybrid approach in solving the university curriculum-based course timetabling problem as presented as part of the 2nd International Timetabling Competition 2007 (ITC2007). The core of the hybrid approach is based on an artificial bee colony algorithm. Past methods have applied artificial bee colony algorithms to university timetabling problems with high degrees of success. Nevertheless, there exist inefficiencies in the associated search abilities in term of exploration and exploitation. To improve the search abilities, this work introduces a hybrid approach entitled nelder-mead great deluge artificial bee colony algorithm (NMGD-ABC) where it combined additional positive elements of particle swarm optimization and great deluge algorithm. In addition, nelder-mead local search is incorporated into the great deluge algorithm to further enhance the performance of the resulting method. The proposed method is tested on curriculum-based course timetabling as presented in the ITC2007. Experimental results reveal that the proposed method is capable of producing competitive results as compared with the other approaches described in literature.

5:00PM *A Discrete Artificial Bee Colony Algorithm for the Economic Lot Scheduling Problem with Returns [#E-14626]*

Onder Bulut and M. Fatih Tasgetiren, Yasar University, Turkey

In this study, we model the Economic Lot Scheduling problem with returns (ELSPR) under the basic period (BP) policy with power-of-two (PoT) multipliers, and solve it with a discrete artificial bee colony (DABC) algorithm. Tang and Teunter is the first to consider the well-known economic lot scheduling problem (ELSP) with return flows and remanufacturing opportunities. Teunter et al. and Zanoni et al. recently extended this first study by proposing heuristics for the common cycle policy and for a modified basic period policy, respectively. As Zanoni et al., we restrict the study to consider independently managed serviceable inventory to test the performance of the proposed algorithm. Our study, to the best of our knowledge, is the first to solve ELSPR using a meta-heuristic. ABC is a swarm-intelligence-based meta-heuristic inspired by the intelligent foraging behaviors of honeybee swarms. In this study, we implement the ABC algorithm with some modifications to handle the discrete decision variables. In the algorithm, we employ two different constraint handling methods in order to have both feasible and infeasible solutions within the population. Our DABC is also enriched with a variable neighborhood search (VNS) algorithm to further improve the solutions. We test the performance of our algorithm on the two problem instances used in Zanoni et al.. The numerical study depicts that the proposed algorithm performs well under the BP-PoT policy and it has the potential of improving the best known solutions when we relax BP, PoT and independently managed serviceable inventory restrictions in the future.

5:20PM *Artificial Bee Colony for Workflow Scheduling [#E-14650]*

Yun-Chia Liang, Hsiang-Ling Chen and Yung-Hsiang Nien, Yuan Ze University, Taiwan; Taoyuan Innovation Institute of Technology, Taiwan

Cloud computing is the provision of computing resource services from which users can obtain resources via network to tackle their demands. In recent years, with fast growing information technology, more users apply this service; as a result, the demand has increased dramatically. In addition, most of the complex tasks are represented by workflow and executed in the cloud. Therefore, as service providers face this increasing demand, how to schedule the workflow and reduce the response time becomes a critical issue. This research integrates the concept of project scheduling with the workflow scheduling problem to formulate a mathematical model, which expects to minimize the total completion time. Two Artificial Bee Colony algorithms are proposed to solve the workflow scheduling optimization problem. The performance of ABC is compared with the optimal solutions obtained by Gurobi optimizer on the instance containing different sizes of workflows. The results show that ABC can be considered a practical method for complicated workflow scheduling problems in the cloud computing environment.

5:40PM *Cooperation Mechanism For Distributed Resource Scheduling Through Artificial Bee Colony Based Self-Organized Scheduling System [#E-14711]*

Ana Madureira, Bruno Cunha and Ivo Pereira, Instituto Superior de Engenharia do Porto, Portugal

In this paper a Cooperation Mechanism for Distributed Scheduling based on Bees based Computing is proposed. Where multiple self-interested agents can reach agreement over the exchange of operations on cooperative resources. Agents must collaborate to improve their local solutions and the global schedule. The proposed cooperation mechanism is able to analyze the scheduling plan generated by the Resource Agents and refine it by idle times reducing taking advantage from cooperative and the self-organized behavior of Artificial Bee Colony technique. The computational study allows concluding about statistical evidence that the cooperation mechanism influences significantly the overall system performance.

6:00PM *Particle Swarm Optimization with Population Adaptation [#E-14502]*

Nanda Dulal Jana, Swagatam Das and Jaya Sil, National Institute of Technology, India; Indian Statistical Institute, India; Bengal Engineering and Science University, India

The Particle Swarm Optimization (PSO) algorithm is a novel population based swarm algorithm has shown good performance on well-known numerical test problems. However, PSO has tends to suffer from premature convergence on multimodal test problems. This is due to lack of diversity of population in search space and leads to stuck at local optima and ultimately fitness stagnation of the population. To enhance the performance of PSO algorithms, in this paper, we propose a method of population adaptation (PA). The proposed method can identify the moment when the population diversity is poor or the population stagnates by measuring the Euclidean distance between particle position and particles average position of a population. When stagnation in the population is identified, the population will be regenerated by normal distribution to increase diversity in the population. The population adaptation is incorporated into the PSO algorithm and is tested on a set of 13 scalable CEC05 benchmark functions. The results show that the proposed population adaptation algorithm can significantly improve the performance of the PSO algorithm with standard PSO, ATREPSO and ARPSO.

Tuesday, July 8, 1:30PM-3:30PM

Special Session: TuE1-1 Evolutionary Computation for Planning and Scheduling

Tuesday, July 8, 1:30PM-3:30PM, Room: 203A, Chair: Jian Xiong

1:30PM *A Benchmark Generator for Dynamic Capacitated Arc Routing Problems [#E-14032]*

Min Liu, Hemant Singh and Tapabrata Ray, University of New South Wales, Australia

Capacitated arc routing problems (CARPs) are usually modeled as static problems, where information is known in advance and assumed to remain constant during the course of optimization. However, in practice, many factors such as demand, road accessibility, vehicle availability etc. change during the course of a mission and the route of each vehicle must be reconfigured dynamically. This problem is referred to as dynamic capacitated arc routing problem (DCARP) and there have been limited attempts to solve such problems in the past. Lack of standard DCARP benchmarks is one of the key factors limiting research in this direction. This paper introduces a benchmark generator for DCARPs considering interruptions/changes that are likely to occur in realistic scenarios. These benchmarks can be used to evaluate the strengths and the weaknesses of various optimization algorithms attempting to solve realistic DCARP problems.

1:50PM *A Co-Evolutionary Teaching-Learning-Based Optimization Algorithm for Stochastic RCPSP [#E-14064]*

Huanyu Zheng, Ling Wang and Shengyao Wang, Tsinghua University, China

A co-evolutionary teaching-learning-based optimization (CTLBO) algorithm is proposed in this paper to solve the stochastic resource-constrained project scheduling problem (SRCPSP). The activity list is used for encoding, and resource-based policies are used for decoding. Also, a new competition phase is developed to select the best solution of each class as the teacher. To make two classes evolve cooperatively, both the teacher phase and student phase of the TLBO are modified. Moreover, Taguchi method of design of experiments is used to investigate the effect of parameter setting. Computational results are provided based on the well-known PSPLIB with certain probability distributions. The comparisons between the CTLBO and some state-of-the-art algorithms are provided. It shows that the CTLBO is more effective in solving the problems with medium to large variance.

2:10PM *A Memetic Algorithm with a New Split Scheme for Solving Dynamic Capacitated Arc Routing Problems [#E-14297]*

Min Liu, Hemant Singh and Tapabrata Ray, University of New South Wales, Australia

Capacitated arc routing problems (CARPs) are usually modeled as static problems, where all information about the problem is known in advance and assumed to remain constant during the course of optimization. However, in practice, many factors such as demand, road accessibility, vehicle availability etc. change during the course of a mission and the routes of each vehicle must be reconfigured dynamically. This problem is referred to as dynamic capacitated arc routing problem (DCARP). In this study, a memetic algorithm with a new split scheme for DCARPs is proposed. This algorithm is capable to solve DCARPs with variations in vehicle availability, road accessibility, added/canceled tasks or demands and traffic congestions. The algorithm is also capable of solving static CARPs. The performance of the algorithm is reported on a 10- node and three 100-node examples in order to demonstrate the efficacy of the algorithm in solving static and dynamic problems.

2:30PM *Agile Earth Observing Satellites Mission Planning Using Genetic Algorithm Based on High Quality Initial Solutions [#E-14585]*

Zang Yuan, Yingwu Chen and Renjie He, National University of Defense Technology, China

This paper presents an improved genetic algorithm to solve the agile earth observing satellite mission planning problem. We study how to rapidly generate high quality initial solutions, and four generation strategies are proposed. The effect of the settings of operator parameters on the performance of the algorithm is analyzed. The experiment results show that the genetic algorithm based on high quality initial solutions generated by Hybrid Random Heuristic Strategy (HRHS) is more effective in solving the agile satellite mission planning problem, but in a certain time cost. We expect that our results will provide insights for the future application of genetic algorithm to satellites mission planning problems.

2:50PM *Behavioral Learning of Aircraft Landing Sequencing Using a Society of Probabilistic Finite State Machines [#E-14754]*

Jiangjun Tang and Hussein Abbass, University of New South Wales, Australia

Air Traffic Control (ATC) is a complex safety critical environment. A tower controller would be making many decisions in real-time to sequence aircraft. While some optimization tools exist to help the controller in some airports, even in these situations, the real sequence of the aircraft adopted by the controller is significantly different from the one proposed by the optimization algorithm. This is due to the very dynamic nature of the environment. The objective of this paper is to test the hypothesis that one can learn from the sequence adopted by the controller some strategies that can act as heuristics in decision support tools for aircraft sequencing. This aim is tested in this paper by attempting to learn sequences generated from a well-known sequencing method that is being used in the real world. The approach relies on a genetic algorithm (GA) to learn these sequences using a society Probabilistic Finite-state Machines (PFSMs). Each PFSM learns a different sub-space; thus, decomposing the learning problem into a group of agents

that need to work together to learn the overall problem. Three sequence metrics (Levenshtein, Hamming and Position distances) are compared as the fitness functions in GA. As the results suggest, it is possible to learn the behavior of the algorithm/heuristic that generated the original sequence from very limited information.

3:10PM *Evolving Machine-Specific Dispatching Rules for a Two-Machine Job Shop using Genetic Programming [#E-14861]*

Rachel Hunt, Mark Johnston and Mengjie Zhang, Victoria University of Wellington, New Zealand

Job Shop Scheduling (JSS) involves determining a schedule for processing jobs on machines to optimise some measure of delivery speed or customer satisfaction. We investigate a genetic programming based hyper-heuristic (GPHH) approach to evolving dispatching rules for a two-machine job shop in both static and dynamic environments. In the static case the proposed GPHH method can represent and discover optimal dispatching rules. In the dynamic case we investigate two representations (using a single rule at both machines and evolving a specialised rule for each machine) and the effect of changing the training problem instances throughout evolution. Results show that relative performance of these methods is dependent on the testing instances.

Special Session: TuE1-2 Swarm Intelligence for Real-World Engineering Optimization

Tuesday, July 8, 1:30PM-3:30PM, Room: 203B, Chair: Boyang Qu

1:30PM *An Enhanced Non-Dominated Sorting Based Fruit Fly Optimization Algorithm for Solving Environmental Economic Dispatch Problem [#E-14067]*

Xiaolong Zheng, Ling Wang and Shengyao Wang, Tsinghua University, China

A fruit fly optimization algorithm based on the enhanced non-dominated sorting (ESFOA) is proposed to solve the environmental economic dispatch (EED) problem. To measure the difference between two non-dominated solutions, the concept of the enhanced non-dominance is defined, and the degrees of dominance and non- dominance are presented. To enhance the parallel search ability, multiple fruit flies groups are used to perform evolutionary search in the ESFOA. In the vision-based search process, the best fruit fly is determined according to the enhanced non-dominance value. To guarantee the feasibility of the new solutions, an effective heuristic mechanism to handle constraints is adopted to repair the infeasible solutions. Meanwhile, an external archive is used to store the non-dominated solutions. The influence of parameter setting is investigated based on the Taguchi method of design of experiment, and a suitable parameter setting is suggested. Finally, numerical tests are carried out by using the IEEE 30-bus benchmark. The comparisons to some existing methods by using the technique for order preference by similarity to ideal solution (TOPSIS) demonstrate the effectiveness of the proposed algorithm.

1:50PM *Particle Swarm Optimization for Integrated Yard Truck Scheduling and Storage Allocation Problem [#E-14536]*

Ben Niu, Ting Xie, Qiqi Duan and Lijing Tan, The Hong Kong Polytechnic University, Hong Kong; Shenzhen University, China; Jinan University, China

The Integrated Yard Truck Scheduling and Storage Allocation Problem (YTS-SAP) is one of the major optimization problems in container port which minimizes the total delay for all containers. To deal with this NP-hard scheduling problem, standard particle swarm optimization (SPSO) and a local version PSO (LPSO) are developed to obtain the optimal solutions. In addition, a simple and effective 'problem mapping' mechanism is used to convert particle position vector into scheduling solution. To evaluate the performance of the proposed approaches, experiments are conducted on different scale instances to compare the results obtained by GA. The experimental studies show that PSOs outperform GA in terms of computation time and solution quality.

2:10PM *Similarity- and Reliability-Assisted Fitness Estimation for Particle Swarm Optimization of Expensive Problems [#E-14596]*

Tong Liu, Chaoli Sun, Jianchao Zeng and Yaochu Jin, Taiyuan University of Science and Technology, China; University of Surrey, United Kingdom

As a population-based meta-heuristic technique for global search, particle swarm optimization (PSO) performs quite well on a variety of problems. However, the requirement on a large number of fitness evaluations poses an obstacle for the PSO algorithm to be applied to solve complex optimization problems with computationally expensive objective functions. This paper extends a fitness estimation strategy for PSO (FESPSO) based on its search dynamics to reduce fitness evaluations using the real fitness function. In order to further save the fitness evaluations and improve the estimation accuracy, a similarity measure and a reliability measure are introduced into the FESPSO. The similarity measure is used to judge whether the fitness of a particle will be estimated or evaluated using the real fitness function, and the reliability measure is adopted to determine whether the approximated value will be trusted. Experimental results on six commonly used benchmark problems show the effectiveness and competitiveness of our proposed algorithm. Preliminary empirical analysis of the search behavior is also performed to illustrate the benefit of the proposed estimation mechanism.

2:30PM *Binary Bacterial Foraging Optimization for Solving 0/1 Knapsack Problem [#E-14605]*

Ben Niu and Ying Bi, The Hong Kong Polytechnic University, Hong Kong; Shenzhen University, China

Knapsack problem is famous NP-complete problem where one has to maximize the benefit of objects in a knapsack without exceeding its capacity. In this paper, a binary bacterial foraging optimization (BBFO) is proposed to find solutions of 0/1 knapsack problems. The original BFO chemotaxis equation is modified to operate in discrete space by using a mapping function, where some new variables and parameter, i.e., binary matrix y, logistic transformation S, and limiting transformation L is built to transform the bacterial position to a binary matrix. By using this schema, the proposed BBFO model can also be easily applied in other discrete problem solving. To further validate the efficiency of the BFO-based approach, an improved version BFO named BFO with linear decreasing chemotaxis step (BFO-LDC) is used to evaluate on six different instances. Comparisons with particle swarm optimization (PSO) and original BFO are presented and discussed.

2:50PM *A Discrete Artificial Bee Colony Algorithm for the Parallel Machine Scheduling Problem in DYO Painting Company [#E-14624]*

Damla Kizilay, M. Fatih Tasgetiren, Onder Bulut and Bilgehan Bostan, Yasar University, Turkey; DYO Painting Company, Turkey

This paper presents a discrete artificial bee colony algorithm to solve the assignment and parallel machine scheduling problem in DYO paint company. The aim of this paper is to develop some algorithms to be employed in the DYO paint company by using their real-life data in the future. Currently, in the DYO paint company; there exist three types of filling machines groups. These are automatic, semiautomatic and manual machine groups, where there are several numbers of identical machines. The problem is to first assign the filling production orders (jobs) to machine groups. Then, filling production orders assigned to each machine group should be scheduled on identical parallel machines to minimize the sum of makespan and the total weighted tardiness. We also develop a traditional genetic algorithm to solve the same problem. The computational results show that the DABC algorithm outperforms the GA on set of benchmark problems we have generated.

3:10PM *Locality-Sensitive Hashing Based Multiobjective Memetic Algorithm for Dynamic Pickup and Delivery Problems [#E-14859]*

Fangxiao Wang, Yuan Gao and Zexuan Zhu, Shenzhen University, China

This paper proposes a locality-sensitive hashing based multiobjective memetic algorithm namely LSH-MOMA for solving pickup and delivery problems with dynamic requests (DPDPs for short). Particularly, LSH-MOMA is designed to find the solution route of a DPDP by optimizing objectives namely workload and route length in an evolutionary manner. In each generation of LSH-MOMA, locality- sensitive hashing based rectification and local search are imposed to repair and refine the individual candidate routes. LSH-MOMA is evaluated on three simulated DPDPs of different scales and the experimental results demonstrate the efficiency of the method.

Special Session: TuE1-3 Complex Networks and Evolutionary Computation

Tuesday, July 8, 1:30PM-3:30PM, Room: 203C, Chair: Jing Liu

1:30PM *A Compression Optimization Algorithm for Community Detection [#E-14181]*

Jianshe Wu, Lin Yuan, Qingliang Gong, Wenping Ma, Jingjing Ma and Yangyang Li, Xidian University, China

Community detection is important in understanding the structures and functions of complex networks. Many algorithms have been proposed. The most popular algorithms detect the communities through optimizing a criterion function known as modularity, which suffer from the resolution limit problem. Some algorithms require the number of communities as a prior. In this paper, a non-modularity based compression optimization algorithm for community detection is proposed without any prior knowledge, which is efficient and is suitable for large scale networks.

1:50PM *Decomposition Based Multiobjective Evolutionary Algorithm for Collaborative Filtering Recommender Systems [#E-14248]*

Shanfeng Wang, Maoguo Gong, Lijia Ma, Qing Cai and Licheng Jiao, Xidian University, China

With the rapid expansion of the information on the Internet, recommender systems play an important role in filtering insignificant information and recommend satisfactory items to users. Accurately predicting the preference of users is the main priority of recommendation. Diversity is also an important objective in recommendation, which is achieved by recommending items from the so-called long tail of goods. Traditional recommendation techniques lay more emphasis on accuracy and overlook diversity. Simultaneously optimizing the accuracy and diversity is a multiobjective optimization problem, in which the two objectives are contradictory. In this paper, a multiobjective evolutionary algorithm based on decomposition is proposed for recommendation, which maximizes the predicted score and the popularity of items simultaneously. This algorithm returns lots of non-dominated solutions and each solution is a trade-off between the accuracy and diversity. The experiment shows that our algorithm can provide a series of recommendation results with different precision and diversity to a user.

2:10PM *A Memetic Algorithm Using Local Structural Information for Detecting Community Structure in Complex Networks [#E-14251]*

Caihong Mu, Jin Xie, Ruochen Liu and Licheng Jiao, Xidian University, China

Community detection has received a great deal of attention in recent years. Modularity is the most used and best known quality function for measuring the quality of a partition of a network. Based on the optimization of modularity, we proposed a memetic algorithm with a local search operator to detect community structure. The local search operator uses a quality function of local community tightness based on structural similarity. In addition, the tactics of vertex mover is used for reassigning vertices to neighboring communities to improve the partition result. Experiments on real-world networks and computer-generated networks show the effectiveness of our algorithm.

2:30PM *Ant Colony Clustering Based on Sampling for Community Detection [#E-14318]*

Xiangjing Song, Junzhong Ji, Cuicui Yang and Xiuzhen Zhang, Beijing University of Technology, China; RMIT University, Australia

Community structure detection in large-scale complex networks has been intensively investigated in recent years. In this paper, we propose a new framework which employs the ant colony clustering algorithm based on sampling to discover communities in large-scale complex networks. The algorithm firstly samples a small number of representative nodes from the large-scale network; secondly it uses the ant colony clustering algorithm to cluster the sampled nodes; thirdly it assigns the un-sampled nodes into the detected communities according to the similarity metric; finally it merges the initial clustering result to sustainably increase the modularity function value of the detection results. A significant advantage of our algorithm is that the sampling method greatly reduces the scale of the problem. Experimental results on computer-generated and realworld networks show the efficiency of our method.

2:50PM *A Differential Evolution Box-Covering Algorithm for Fractal Dimension on Complex Networks [#E-14354]*

Li Kuang, Zhiyong Zhao, Feng Wang, Yuanxiang Li, Fei Yu and Zhijie Li, Wuhan University, China

The fractality property are discovered on complex networks through renormalizaiton procedure, which is implemented by box-covering method. The unsolved problem of box-covering method is to find the minimum number of boxes to cover the whole network. Here, we introduce a differential evolution box- covering algorithm based on greedy graph coloring approach. We apply our algorithm on some benchmark networks with different structures, such as the E.coli metabolic network, which has low clustering coefficient and high modularity, the Clustered scale-free network, which has high clustering coefficient and low modularity, and some community networks (the Politics books network, the Dolphins network, and the American football games network), which have high clustering coefficient. Experimental results show that our DEBC algorithm can get better results than state of art

algorithms in most cases, especially has significant improvement in clustered community networks.

3:10PM *An Intelligent Ant Colony Optimization for Community Detection in Complex Networks [#E-14404]*
Caihong Mu, Jian Zhang and Licheng Jiao, Xidian University, China

Many systems in social world can be represented by complex networks. It is of great significance to detect the community structure and analyze the functions for networks. In recent years, plenty of research and works have been focused on this problem. In this paper, we propose an enhanced algorithm based on ant colony optimization (ACO) for the community detection problems. In order to avoid redundant computing in ACO, we divide the ant colony into two groups, original group and intelligent group, which search the solution space simultaneously. In the intelligent group, due to the locus-based adjacency representation of the solution, we let some of them have an ability of self-learning and others can learn from the optimal solutions proactively. Experiments on synthetic and real-life networks show the proposed algorithm can explore in an efficient and stable way.

Special Session: TuE1-4 Evolutionary Algorithms with Statistical and Machine Learning Techniques

Tuesday, July 8, 1:30PM-3:30PM, Room: 203D, Chair: Aimin Zhou

1:30PM *HMOEDA_LLE: A Hybrid Multi-Objective Estimation of Distribution Algorithm Combining Locally Linear Embedding [#E-14066]*
Yuzhen Zhang, Guangming Dai, Lei Peng and Maocai Wang, China University of Geosciences (Wuhan), China

Based on the regularity that: the Pareto set of a continuous m-objectives problem is a piecewise continuous (m-1)-dimensional manifold, a novel hybrid multi-objective optimization algorithm is proposed in this paper. In the early evolutionary stage, traditional crossover and mutation operations are used to produce offspring, in addition, the locally linear embedding (LLE) with small neighbor parameter approach is introduced to learn the local geometry of the manifold. When certain regularity in population's distribution is detected, new offspring are sampled from the probability models created by the statistical distribution information. An entropy-based criterion is imported to determine the switching time of the two different phases of evolutionary search. The proposed hybrid multi-objective estimation of distribution algorithm combining locally linear embedding (HMOEDA_LLE) adopts several widely used test problems to conduct the comparison experiments with two state-of-the-art multi-objective evolutionary algorithms NSGA-II and RM-MEDA. The simulated results show the effectiveness of the entropy-based criterion and the proposed algorithm has better optimization performance.

1:50PM *Behavioral Study of the Surrogate Model-Aware Evolutionary Search Framework [#E-14329]*
Bo Liu, Qin Chen, Qingfu Zhang, Georges Gielen and Vic Grout, Glyndwr University, United Kingdom; China Aerodynamic Research and Development Center, China; University of Essex, United Kingdom; Katholieke Universiteit Leuven, Belgium

The surrogate model-aware evolutionary search (SMAS) framework is an emerging model management method for surrogate model assisted evolutionary algorithms (SAEAs). SAEAs based on SMAS outperform several state-of-the-art SAEAs using other model management methods and show promising results in real-world computationally expensive optimization problems. However, there is little behavioral study of the SMAS framework, and appropriate rules for its search strategy, training data selection and key parameter selection for different types of problems have not been provided yet. In this paper, with a newly proposed training data selection method, the SMAS framework's behaviour with different search strategies and training data selection methods is investigated. The empirical rules in terms of problem characteristics are obtained and the method to construct an SAEA based on the SMAS framework is updated. Experiments using 24 widely used benchmark test problems and the test problems in the CEC 2014 competition of computationally expensive optimization are carried out, which validate the proposed empirical rules.

2:10PM *A Clustering Based Multiobjective Evolutionary Algorithm [#E-14618]*
Hu Zhang, Shenmin Song, Aimin Zhou and Xiao-Zhi Gao, Harbin Institute of Technology, China; East China Normal University, China; Aalto University, Finland

In this paper, we propose a clustering based multiobjective evolutionary algorithm (CLUMOEA) to deal with the multiobjective optimization problems with irregular Pareto front shapes. CLUMOEA uses a k-means clustering method to discover the population structure by partitioning the solutions into several clusters, and it only allows the solutions in the same cluster to do the reproduction. To reduce the computational cost and balance the exploration and exploitation, the clustering process and evolutionary process are integrated together and they are performed simultaneously. In addition to the clustering, CLUMOEA also uses a distance tournament selection to choose the more similar mating solutions to accelerate the convergence. Besides, a cosine nondominated selection method considering the location and distance information of the solutions are further presented to construct the final population with good diversity. The experimental results show that, compared with some stateof-the- art algorithms, CLUMOEA has significant advantages on dealing with the given test problems with irregular Pareto front shapes.

2:30PM *Creating Stock Trading Rules Using Graph-Based Estimation of Distribution Algorithm [#E-14421]*
Xianneng Li, Wen He and Kotaro Hirasawa, Waseda University, Japan

Though there are numerous approaches developed currently, exploring the practical applications of estimation of distribution algorithm (EDA) has been reported to be one of the most important challenges in this field. This paper is dedicated to extend EDA to solve one of the most active research problems -- stock trading, which has been rarely revealed in the EDA literature. A recent proposed graph- based EDA called reinforced probabilistic model building genetic network programming (RPMBGNP) is investigated to create stock trading rules. With its distinguished directed graph-based individual structure and the reinforcement learning-based probabilistic modeling, we demonstrate the effectiveness of RPMBGNP for the stock trading task through real-market stock data, where much higher profits are obtained than traditional non-EDA models.

2:50PM *Grammar Based Genetic Programming with Bayesian Network [#E-14423]*
Pak-Kan Wong, Leung-Yau Lo, Man-Leung Wong and Kwong-Sak Leung, The Chinese University of Hong Kong, Hong Kong; Lingnan University, Hong Kong

Grammar-Based Genetic Programming (GBGP) improves the search performance of Genetic Programming (GP) by formalizing constraints and domain specific knowledge in grammar. The building blocks (i.e. the functions and the terminals) in a program can be dependent. Random crossover and mutation destroy the dependence with a high probability, hence breeding a poor program from good programs. Understanding on the syntactic and semantic in the grammar plays an important role to boost the efficiency of GP by reducing the number of poor breeding. Therefore, approaches have been proposed by introducing context sensitive ingredients encoded in probabilistic models. In this paper, we propose Grammar-Based Genetic Programming with Bayesian Network (BGBGP) which learns the dependence by attaching a Bayesian network to each derivation rule and demonstrates its effectiveness in two benchmark problems.

3:10PM *A First Attempt on Evolutionary Prototype Reduction for Nearest Neighbor One-Class Classification [#E-14521]*

Bartosz Krawczyk, Isaac Triguero, Salvador Garcia, Michal Wozniak and Francisco Herrera, University of Wroclaw, Poland; University of Granada, Spain; University of Jaen, Spain

Evolutionary prototype reduction techniques are data preprocessing methods originally developed to enhance the nearest neighbor rule. They reduce the training data by selecting or generating representative examples of a given problem. These algorithms have been designed and widely analyzed in standard classification providing very competitive results. However, its application scope can be extended to many other specific domains, such as one-class classification, in which its way of working is very interesting in order to reduce computational complexity and sensitivity to noisy data. In this contribution, we perform a first study on the usefulness of evolutionary prototype reduction methods for one-class classification. To do so, we will focus on two recent evolutionary approaches that follow very different strategies: selection and generation of examples from the training data. Both alternatives provide a resulting preprocessed data set that will be used later by a nearest neighbor one-class classifier as its training data. The results achieved support that these data reduction techniques are suitable tools to improve the performance of the nearest neighbor one-class classification.

Tuesday, July 8, 3:30PM-6:00PM

Poster Session: PE2 Poster Session II

Tuesday, July 8, 3:30PM-6:00PM, Room: Posters Area (Level 2), Chair: Tadahiko Murata

P301 *A Multi-Swarm Particle Swarm Optimization with Orthogonal Learning for Locating and Tracking Multiple Optima in Dynamic Environments [#E-14203]*

Ruochen Liu, Xu Niu and Licheng Jiao, Xidian University, China

Due to the specificity and complexity of the dynamic optimization problems (DOPs), those excellent static optimization algorithms cannot be applied in these problems directly. So some special algorithms only for DOPs are needed. There is a multi-swarm algorithm with a better performance than others in DOPs, which utilizes a parent swarm to explore the search space and some child swarms to exploit promising areas found by the parent swarm. In addition, a static optimization algorithm OLPSO is so attractive, which utilize an orthogonal learning (OL) strategy to utilize previous search information (experience) more efficiently to predict the positions of particles and improve the convergence speed. In this paper, we bring the essence of OLPSO called OL strategy to the multi-swarm algorithm to improve its performance further. The experimental results conducted on different dynamic environments modeled by moving peaks benchmark show that the efficiency of this algorithm for locating and tracking multiple optima in dynamic environments is outstanding in comparison with other particle swarm optimization models, including MPSO, a similar particle swarm algorithm for dynamic environments.

P302 *Regression Ensemble with PSO Algorithms Based Fuzzy Integral [#E-14259]*

James Liu, Yulin He and Yanxing Hu, The Hong Kong Polytechnic University, Hong Kong; Hebei University, China

Similar to the ensemble learning for classification, regression ensemble also tries to improve the prediction accuracy through combining several ``weak'' estimators which are usually high-variance and thus unstable. In this paper, we propose a new scheme of fusing the weak Priestley-Chao Kernel Estimators (PCKEs) based on Choquet fuzzy integral, which differs from all the existing models of regressor fusion. The new scheme uses Choquet fuzzy integral to fuse several target outputs from different PCKEs, in which the optimal bandwidths are obtained with cross-validation criteria. The key of applying fuzzy integral to PCKE fusion is the determination of fuzzy measure. Considering the advantage of particle swarm optimization (PSO) algorithm on convergence rate, we use three different PSO algorithms, i.e., standard PSO (SPSO), Gaussian PSO (GPSO) and GPSO with Gaussian jump (GPSOGJ), to determine the general and λ fuzzy measures. The finally experimental results on 6 standard testing functions show that the new paradigm for regression ensemble based on fuzzy integral is more accurate and stable in comparison with any individual PCKE. This demonstrates the feasibility and effectiveness of our proposed regression ensemble model.

P303 *An Improved Quantum-Behaved Particle Swarm Optimization Based on Linear Interpolation [#E-14286]*

Shouyong Jiang and Shengxiang Yang, De Montfort Univesity, United Kingdom

Quantum-behaved particle swarm optimization (QPSO) has shown to be an effective algorithm for solving global optimization problems that are of high complexity. This paper presents a new QPSO algorithm, denoted LI-QPSO, which employs a model-based linear interpolation method to strengthen the local search ability and improve the precision and convergence performance of the QPSO algorithm. In LI-QPSO, linear interpolation is used to approximate the objective function around a pre-chosen point with high quality in the search space. Then, local search is used to generate a promising trial point around this pre-chosen point, which is then used to update the worst personal best point in the swarm. Experimental results show that the proposed algorithm provides some significant improvements in performance on the tested problems.

P304 *Evolving Hierarchical Gene Regulatory Networks for Morphogenetic Pattern Formation of Swarm Robotics [#E-14312]*

Hyondong Oh and Yaochu Jin, University of Surrey, United Kingdom

Morphogenesis, the biological developmental process of multicellular organisms, is a robust self-organising mechanism for pattern formation governed by gene regulatory networks (GRNs). Recent findings suggest that GRNs often show the use of frequently recurring patterns termed network motifs. Inspired by these biological studies, this paper proposes a morphogenetic approach to pattern formation for swarm robots to entrap targets based on an evolving hierarchical gene regulatory network (EH-GRN). The proposed EH-GRN consists of two layers: the upper layer is for adaptive pattern generation where the GRN model is evolved by basic network motifs, and the lower layer is responsible for driving robots to the target pattern generated by the upper layer. Obstacle information is introduced as one of environmental inputs along with that of targets in order to generate an adaptive pattern to unknown environmental changes. Besides, splitting or

merging of multiple patterns resulting from target movement is addressed by the inherent feature of the upper layer and the k-means clustering algorithm. Numerical simulations have been performed for scenarios containing static/moving targets and obstacles to validate the effectiveness and benefit of the proposed approach for complex shape generation in dynamic environments.

P305 *Avoiding Decoys in Multiple Targets Searching Problems Using Swarm Robotics [#E-14336]*

Zhongyang Zheng, Junzhi Li, Jie Li and Ying Tan, Peking University, China

In this paper, we consider the target searching problems with a new type of the object: decoys which can be sensed exactly as targets but cannot be collected by the robots. In real-life applications, decoys are very common especially for swarm robots whose hardware should be designed as simple and cheap as possible. This inevitably brings errors and mistakes in the sensing results and the swarm may mistakenly sense certain kinds of environment objects as the target they are looking for. We proposed a simple cooperative strategy to solve this problem, comparing with a non-cooperative strategy as the baseline. The strategies work with other searching algorithms and provide schemes for avoiding decoys. Simulation results demonstrate that the cooperative strategy shares almost the same computation overload yet has better performance in iterations and especially visited times of decoys. The strategy shows great adaptiveness to large scale problems and performs better when more decoys or robots exist in the simulation.

P306 *Particle Swarm Optimization for Integrity Monitoring in BDS/DR Based Railway Train Positioning [#E-14860]*

Jiang Liu, Bai-gen Cai and Jian Wang, Beijing Jiaotong University, China

Satellite navigation system, especially the BeiDou Navigation Satellite System (BDS), has become a significant resource for many transport branches. It is strongly required that BDS is applied in modern railway transportation systems to support the rapid development of Chinese railway infrastructure and services. Currently, the BDS is still in the developing period, and the existing resources are not sufficient to support integrity assurance for many safety-related railway applications. The aim of this paper is therefore to develop a novel integrity monitoring method for the BDS-based train positioning with assistance from the additional dead reckoning system. In this method, the raw measurements of sensors are fused with the Bayesian filtering, and the self-weight adaptive particle swarm optimization with a combined objective function is involved to achieve an effective solution for the horizontal protection level which indicates the integrity capability. Field data are taken to validate effectiveness of the proposed solution and the advantages of the integrated particle fitness strategy. The implementation of this method will be positive for realizing fault detection and isolation for a series of safety-related railway applications based on BDS.

P307 *Learning and Evolution of Genetic Network Programming with Knowledge Transfer [#E-14211]*

Xianneng Li, Wen He and Kotaro Hirasawa, Waseda University, Japan

Traditional evolutionary algorithms (EAs) generally starts evolution from scratch, in other words, randomly. However, this is computationally consuming, and can easily cause the instability of evolution. In order to solve the above problems, this paper describes a new method to improve the evolution efficiency of a recently proposed graph-based EA - genetic network programming (GNP) - by introducing knowledge transfer ability. The basic concept of the proposed method, named GNP-KT, arises from two steps: First, it formulates the knowledge by discovering abstract decision-making rules from source domains in a learning classifier system (LCS) aspect; Second, the knowledge is adaptively reused as advice when applying GNP to a target domain. A reinforcement learning (RL)-based method is proposed to automatically transfer knowledge from source domain to target domain, which eventually allows GNP-KT to result in better initial performance and final fitness values. The experimental results in a real mobile robot control problem confirm the superiority of GNP-KT over traditional methods.

P308 *An Improved JADE Algorithm for Global Optimization [#E-14215]*

Ming Yang, Zhihua Cai, Changhe Li and Jing Guan, China University of Geosciences (Wuhan), China; China Ship Development and Design Center, China

In differential evolution (DE), the optimal value of the control parameters are problem-dependent. Many improved DE algorithms have been proposed with the aim of improving the effectiveness for solving general problems. As a very known adaptive DE algorithm, JADE adjusts the crossover probability CR of each individual by a norm distribution, in which the value of standard deviation is fixed, based on its historical record of success. The fixed and small standard deviation results in that the generated CR may not suitable for solving a problem. This paper proposed an improvement for the adaptation of CR, in which the standard deviation is adaptive. The diversity of values of CR was improved. This improvement was incorporated into the JADE algorithm and tested on a set of 25 scalable benchmark functions. The results showed that the adaptation of CR improved the performance of the JADE algorithm, particularly in comparisons with several other peer algorithms on high-dimensional functions.

P309 *Characterizing the Impact of Selection on the Evolution of Cooperation in Complex Networks [#E-14239]*

Shasha Feng, Shaolin Tan and Jinhu Lu, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, China; Hunan University, China

Cooperative behaviors are widespread in biological and social populations. Yet the evolution of cooperation is still a puzzle in evolutionary theory. Recent researches have indicated that complex interactions among individuals may promote the evolution of cooperation under weak selection. However, the selection effect on cooperation has not been completely understood. This paper aims to characterize the impact of selection on the emergence of cooperation in evolutionary dynamics on complex networks. By theoretical analysis and numerical simulation, it is found that selection favors defection over cooperation for the birth-death process, while it may favor cooperation over defection for the death-birth process. Furthermore, we come to the condition on which cooperation is dominant over defection. In particular, there exists an optimal selection intensity which favors cooperation the best for the death-birth process. The obtained results indicate that appropriate selection can promote the evolution of cooperation in structured populations under some circumstances.

P310 *A Tabu Search Heuristic for the Single Row Layout Problem with Shared Clearances [#E-14283]*

Meng Yu, Xingquan Zuo and Chase C. Murray, Beijing University of Posts and Telecommunications, China; Auburn University, United States

The single row layout problem is a common and well-studied practical facility layout problem. The problem seeks the arrangement of a fixed number of facilities along one row that minimizes the objective of total material handling cost. In this paper, a single row layout problem with shared clearance between facilities is proposed. The shared additional clearance may be considered on one or both sides of each facility. To solve this problem tabu search is combined with a heuristic rule to solve problems of realistic size. Tabu search is used to find the sequence of facilities while the heuristic rule is determines the additional clearance for each facility. The proposed solution approach is applied to several problem instances involving 10, 20 and 30 facilities, and is compared against a popular mathematical programming solver (CPLEX). Computational results show that our approach is able to obtain high quality solutions and outperforms CPLEX under limited computational time for problems of realistic sizes.

P311 *A Weighting-Based Local Search Heuristic Algorithm for the Set Covering Problem [#E-14290]*

Chao Gao, Thomas Weise and Jinlong Li, University of Science and Technology of China, China

The Set Covering Problem (SCP) is NP-hard and has many applications. In this paper, we introduce a heuristic algorithm for SCPs based on weighting. In our algorithm, a local search framework is proposed to perturb the candidate solution under the best objective value found during the search, a weighting scheme and several search strategies are adopted to help escape from local optima and make the search more divergent. The effectiveness of our algorithm is evaluated on a set of instances from the OR-Library and Steiner triple systems. The experimental results show that it is very competitive, for it is able to find all the optima or best known results with very small runtimes on non-unicost instances from the OR- Library and outperforms two excellent solvers we have found in literature on the unicost instances from Steiner triple systems. Furthermore, it is conceptually simple and only needs one parameter to indicate the stopping criterion.

P312 *Parallelization for Space Trajectory Optimization [#E-14294]*

Martin Schlueter and Masaharu Munetomo, Hokkaido University, Japan

The impact of parallelization on the optimization process of space mission trajectories is investigated in this contribution. As space mission trajectory reference model, the well known Cassini1 benchmark, published by the European Space Agency (ESA), is considered and solved here with the MIDACO optimization software. It can be shown that significant speed ups can be gained by applying parallelization.

P313 *Optimal Approximation of Stable Linear Systems with a Novel and Efficient Optimization Algorithm [#E-14316]*

Qiaoyong Jiang, Lei Wang, Xinhong Hei, Rong Fei, Dongdong Yang, Feng Zou, Hongye Li and Zijian Cao, Xi'an University of Technology, China

Optimal approximation of linear system models is an important task in the controller design and simulation for complex dynamic systems. In this paper, we put forward a novel nature-based meta-heuristic method, called artificial raindrop algorithm, which is inspired from the phenomenon of natural rainfall, and apply it for optimal approximation for a stable linear system. It mimics the changing process of a raindrop, including the generation of raindrop, the descent of raindrop, the collision of raindrop, the flowing of raindrop and the updating of raindrop. Five corresponding operators are designed in the algorithm. Numerical experiment is carried on optimal approximation of a typical stable linear system in two fixed search intervals. The result demonstrates better performance of the proposed algorithm comparing with that of other five state-of-the-art optimization algorithms.

P314 *Extending Minimum Population Search Towards Large Scale Global Optimization [#E-14330]*

Antonio Bolufe-Rohler and Stephen Chen, University of Havana, Cuba; York University, Canada

Minimum Population Search is a new metaheuristic specifically designed for multi-modal optimization. Its core idea is to guarantee exploration in all dimensions of the search space with the smallest possible population. A small population increases the chances of convergence and the efficient use of function evaluations - an important consideration when scaling a search technique up towards large scale global optimization. As the cost to converge to any local optimum increases in high dimensional search spaces, metaheuristics must focus more and more on gradient exploitation. To successfully maintain its balance between exploration and exploitation, Minimum Population Search uses thresheld convergence. Thresheld convergence can ensure that a search technique will perform a broad, unbiased exploration at the beginning and also have enough function evaluations allocated for proper convergence at the end. Experimental results show that Minimum Population Search outperforms Differential Evolution and Particle Swarm Optimization on complex multi-modal fitness functions across a broad range of problem sizes.

P315 *A New Penalty Function Method for Constrained Optimization Using Harmony Search Algorithm [#E-14333]*

Biao Zhang, Jun-hua Duan, Hong-yan Sang, Jun-qing Li and Hui Yan, Liaocheng University, China

This paper proposes a novel penalty function measure for constrained optimization using a new harmony search algorithm. In the proposed algorithm, a two-stage penalty is applied to the infeasible solutions. In the first stage, the algorithm can search for feasible solutions with better objective values efficiently. In the second stage, the algorithm can take full advantage of the information contained in infeasible individuals and avoid trapping in local optimum. In addition, for adapting to this method, a new harmony search algorithm is presented, which can keep a balance between exploration and exploitation in the evolution process. Numerical results of 13 benchmark problems show that the proposed algorithm performs more effectively than the ordinary methods for constrained optimization problems.

P316 *Scatter Search Algorithm with Chaos Based Stochasticity [#E-14120]*

Donald Davendra, Roman Senkerik, Ivan Zelinka and Michal Pluhacek, VSB - Technical University of Ostrava, Czech Republic; Tomas Bata University in Zlin, Czech Republic

In this paper, we introduce a Scatter Search algorithm which is driven using a set of four chaos maps. The chaos maps of Tinkerbell, Delayed Logistics, Lozi and Burgers are used as chaotic pseudorandom number generators in the Scatter Search algorithm. These variants of the algorithm are used to solve the flowshop with blocking problem. The results are compared with the Mersenne Twister version of Scatter Search. The new chaos driven Scatter Search algorithm is shown to have superior performance when compared with state of the art heuristics in literature.

P317 *Co-Operation of Biology Related Algorithms Meta-Heuristic in ANN-Based Classifiers Design [#E-14674]*

Shakhnaz Akhmedova and Eugene Semenkin, Siberian State Aerospace University, Russia

Meta-heuristic called Co-Operation of Biology Related Algorithms (COBRA), that has earlier demonstrated its usefulness on CEC'2013 real-valued optimization competition benchmark, is applied to ANN-based classifiers design. The basic idea consists in representation of ANN's structure as a binary string and the use of the binary modification of COBRA for the ANN's structure selection. Neural network's weight coefficients represented as a string of real-valued variables are adjusted with the original version of COBRA. Four benchmark classification problems (two bank scoring problems and two medical diagnostic problems) are solved with this approach. Multilayered feed-forward ANNs with maximum 5 hidden layers and maximum 5 neurons on each layer are used. It means that ANN's structure optimal selection requires solving an optimization problem with 100 binary variables. Fitness function calculation for each bit string requires solving an optimization problem with up to 225 real-valued variables. Experiments showed that both variants of COBRA demonstrate high performance and reliability in spite of the complexity of solved optimization problems. ANN-based classifiers developed in this way outperform many alternative methods on mentioned benchmark classification problems. The workability and usefulness of proposed meta-heuristic optimization algorithms are confirmed.

P318 *Scientific Algorithms for the Car Renter Salesman Problem [#E-14681]*

Denis Felipe, Elizabeth Goldbarg and Marco Goldbarg, Universidade Federal do Rio Grande do Norte, Brazil

This paper presents the Scientific Algorithms, a new metaheuristics inspired in the scientific research process. The new method introduces the idea of theme to search the solution space of hard problems. The inspiration for this class of algorithms comes from the act of researching that comprises thinking, knowledge sharing and disclosing new ideas. The ideas of the new method are illustrated in the Traveling Salesman Problem. A computational experiment applies the proposed approach to a new variant of the Traveling Salesman Problem named Car Renter Salesman Problem. The results are compared to state-of-the-art algorithms for the latter problem.

P319 *A Proposal on Analysis Support System Based on Association Rule Analysis for Non-Dominated Solutions [#E-14855]*

Shinya Watanabe, Yuta Chiba and Masahiro Kanazaki, Muroran Institute of Technology, Japan; Accenture Japan Ltd, Japan; Tokyo Metropolitan University, Japan

This paper presents a new analysis support system for analyzing non-dominated solutions (NDSs) derived by evolutionary multi-criterion optimization (EMO). The main features of the proposed system are to use association rule analysis and to perform a multi-granularity analysis based on a hierarchical tree of NDSs. The proposed system applies association rule analysis to the whole NDSs and derives association rules related to NDSs. And a hierarchical tree is created through our original association rule grouping that guarantees to keep at least one common features. Each node of a hierarchical tree corresponds to one group consisting of association rules and is fixed in position according to inclusion relations between groups. Since each group has some kinds of common features, the designer can analyze each node with previous knowledge of these common features. To investigate the characteristics and effectiveness of the proposed system, the proposed system is applied to the concept design problem of hybrid rocket engine (HRE) which has two objectives and six variable parameters. HRE separately stores two different types of thrust propellant unlike in the case of usual other rockets and the concept design problem of HRE has been provided by JAXA. The results of this application provided possible to analyze the trends and specifics contained in NDSs in an organized way unlike analysis approaches targeted at the whole NDSs.

P320 *GEAS: A GA-ES-Mixed Algorithm for Parameterized Optimization Problems - Using CLS Problem as an Example [#E-14417]*

Xing Zhou, Wei Peng and Bo Yang, National University of Defense Technology, China

Parameterized optimization problems (POPs) belong to a class of NP problems which are hard to be tackled by traditional methods. However, the relationship of the parameters (usually represented as k) makes a POP different from ordinary NP- complete problem in designing algorithms. In this paper, GEAS, an evolutionary computing algorithm (also can be seen as a framework) to solve POPs is proposed. This algorithm organically unifies genetic algorithm (GA) framework and the idea of evolutionary strategy (ES). It can maintain diversity while with a small population and has an intrinsic parallelism property:each individual in the population can solve a same problem that only has a different parameter. GEAS is delicately tested on an NP-complete problem, the \textit {Critical Link Set Problem}. Experiment results show that GEAS can converge much faster and obtain more precise solution than GA which uses the same genetic operators.

P321 *Application of Computational Intelligence for Source Code Classification [#E-14179]*

Marcos Alvares, Fernando Buarque and Tshilidzi Marwala, University of Johannesburg, South Africa; Polytechnic School of Pernambuco, Brazil

Multi-language Source Code Management systems have been largely used to collaboratively manage software development projects. These systems represent a fundamental step in order to fully use communication enhancements by producing concrete value on the way people collaborate to produce more reliable computational systems. These systems evaluate results of analyses in order to organise and optimise source code. These analyses are strongly dependent on technologies (i.e. framework, programming language, libraries) each of them with their own characteristics and syntactic structure. To overcome such limitation, source code classification is an essential pre-processing step to identify which analyses should be evaluated. This paper introduces a new approach for generating content-based classifiers by using Evolutionary Algorithms. Experiments were performed on real world source code collected from more than 200 different open source projects. Results show us that our approach can be successfully used for creating more accurate source code classifiers. The resulting classifier is also expansible and flexible to new classification scenarios (opening perspectives for new technologies).

P322 *Genetic Algorithm with Spatial Receding Horizon Control for the Optimization of Facility Locations [#E-14202]*

Xiao-Bing Hu and Mark S Leeson, Beijing Normal University, China; University of Warwick, United Kingdom

Inspired by the temporal receding horizon control in control engineering, this paper reports a novel spatial receding horizon control (SRHC) strategy to partition the facility location optimization problem (FLOP), in order to reduce the complexity caused by the problem scale. Traditional problem partitioning methods can be viewed as a special case of the proposed SRHC, i.e., one-step- wide SRHC, whilst the method in this paper is a generalized N-step-wide SRHC, which can make a better use of global information of the route network where a given number of facilities need to be set up. With SRHC to partition the FLOP, genetic algorithm (GA) is integrated as optimizer to resolve the partitioned problem within each spatial receding horizon. On one hand, SRHC helps to improve the scalability of GA. On the other, the population feature of GA helps to reduce the shortsighted performance of SRHC. The effectiveness and efficiency of the reported SRHC and GA for the FLOP are demonstrated by comparative simulation results.

P323 *Tuning a Multiple Classifier System for Side Effect Discovery Using Genetic Algorithms [#E-14243]*

Jenna Reps, Uwe Aickelin and Jonathan Garibaldi, University of Nottingham, United Kingdom

In previous work, a novel supervised framework implementing a binary classifier was presented that obtained excellent results for side effect discovery. Interestingly, unique side effects were identified when different binary classifiers were used within the framework, prompting the investigation of applying a multiple classifier system. In this paper we investigate tuning a side effect multiple classifying system using genetic algorithms. The results of this research show that the novel framework implementing a multiple classifying system trained using genetic algorithms can obtain a higher partial area under the receiver operating characteristic curve than implementing a single classifier. Furthermore, the framework is able to detect side effects efficiently and obtains a low false positive rate.

P324 *Cooperation with Potential Leaders in Evolutionary Game Study of Networking Agents [#E-14308]*

Jianlei Zhang, Chunyan Zhang, Tianguang Chu and Ming Cao, University of Groningen, Netherlands; Peking University, China

Increasingly influential leadership is significant to the cooperation and success of human societies. However, whether and how leaders emerge among evolutionary game players still remain less understood. Here, we study the evolution of potential leaders in the framework of evolutionary game theory, adopting the prisoner's dilemma and snowdrift game as metaphors of cooperation between unrelated individuals. We find that potential leaders can spontaneously emerge from homogeneous populations along with the evolution of cooperation, demonstrated by the result that a minority of agents spread their strategies more successfully than others and guide the population behavior, irrespective of the applied games. In addition, the phenomenon just described can be observed more notably in populations situated on scale free networks, and thus implies the relevance of

heterogeneous networks for the possible emergence of leadership in the proposed system. Our results underscore the importance of the study of leadership in the population indulging in evolutionary games.

P325 *Multi-Objective Optimization Model Based on Steady Degree for Teaching Building Evacuation [#E-14395]*

Pengfei Duan, Shengwu Xiong, Zhongbo Hu, Qiong Chen and Xinlu Zhong, Wuhan University of Technology, China; WISDRI Engineering and Research Incorporation Limited, China; Hubei University of Technology, China

In this paper, the process of evacuation in teaching building is considered. The concept of steady degree based on cellular automata and potential field is introduced and it can describe the behavior tendency of evacuees during the evacuation process. With the help of steady degree, the model simulates the indoor evacuation behavior. To reduce the congestion and evacuation time, a multi-objective optimization model considering steady degree and evacuation clearance time is proposed. Finally, an experiment in the Teaching Building No.1 of Wuhan University of Technology is carried out. The results show that this model can reduce the clearance time of emergency evacuation in teaching building compared to other models.

P326 *Evolutionary Clustering Algorithm for Community Detection Using Graph-Based Information [#E-14680]*

Gema Bello-Orgaz and David Camacho, Universidad Autonoma de Madrid, Spain

The problem of community detection has become highly relevant due to the growing interest in social networks. The information contained in a social network is often represented as a graph. The idea of graph partitioning of graph theory can be apply to split a graph into node groups based on its topology information. In this paper the problem of detecting communities within a social network is handled applying graph clustering algorithms based on this idea. The new approach proposed is based on a genetic algorithm. A new fitness function has been designed to guide the clustering process combining different measures of network topology (Density, Centralization, Heterogeneity, Neighbourhood, Clustering Coefficient). These different network measures have been experimentally tested using a real-world social network. Experimental results show that the proposed approach is able to detect communities and the results obtained in previous work have been improved.

P327 *Applying Conversion Matrix to Robots for Imitating Motion Using Genetic Algorithms [#E-14684]*

Mari Nishiyama and Hitoshi Iba, The University of Tokyo, Japan

In this paper, we propose a method using a genetic algorithm (GA) for motion imitation between two different types of humanoid robots. Although motion imitation between humans and robots has been a popular research topic for a long time, the imitation between different types of robots still remains an unsolved task. The selection of the correct joint angles is critical for robot motion. However, different robots have different anatomies, with each joint's position and movable range uniquely defined for each type of robot. This discrepancy is an obstacle when converting a motion to another type of robot. The proposed method uses a genetic algorithm in order to find the conversion matrix needed to map one robot's joint angles to joint angles of another robot. This is done with two objectives in mind; one is to reduce the difference between the sample imitation and the converted imitation. The other one is to keep the stability. Two experiments were conducted; one stable and one unstable experiment. The experiments were made with two different types of robots in a simulation environment. The stable experiment showed a concordance rate of 93.7% with the test motion. The imitation also tested with the real robot and succeeded to keep standing. In the unstable experiment, the student robot keeps its balance for most of the simulation time. It showed a concordance rate of 95.5%, which is slightly higher than that in the stable experiment. These results show great promise for the proposed method as a way to realize motion imitation between different types of robots.

P328 *Optimization of Combinational Logic Circuits Through Decomposition of Truth Table and Evolution of Sub-Circuits [#E-14699]*

Francisco Manfrini, Helio Barbosa and Heder Bernadino, Federal University of Juiz de Fora, Brazil

In this work, a genetic algorithm was used to design combinational logic circuits (CLCs), with the goal of minimizing the number of logic elements in the circuit. A new coding for circuits is proposed using a multiplexer (MUX) at the output of the circuit. This MUX divides the truth table into two distinct parts, with the evolution occurring in three sub-circuits connected to the control input and the two data inputs of the MUX. The methodology presented was tested with some benchmark circuits. The results were compared with those obtained using traditional design methods, as well as the results found in other articles, which used different heuristics to design CLCs.

P329 *Reordering Dimensions for Radial Visualization of Multidimensional Data - A Genetic Algorithms Approach [#E-14790]*

Binh Huynh Thi Thanh, Long Tran Van, Hoai Nguyen Xuan, Anh Nguyen Duc and Truong Pham Manh, Hanoi University of Science and Technology, Viet Nam; University of Communications and Transport, Viet Nam; Hanoi University, Viet Nam

In this paper, we propose a Genetic Algorithm (GA) for solving the problem of dimensional ordering in Radial Visualization (Radviz) systems. The Radviz is a non-linear projection of high-dimensional data set onto two dimensional space. The order of dimension anchors in the Radviz system is crucial for the visualization quality. We conducted experiments on five common data sets and compare the quality of solutions found by GA and those found by the other well-known methods. The experimental results show that the solutions found by GA for these tested data sets are very competitive having better cost values than almost all solutions found by other methods. This suggests that GA could be a good approach to solve the problem of dimensional ordering in Radviz.

P330 *An Evolutionary Approach for Combining Results of Recommender Systems Techniques Based on Collaborative Filtering [#E-14821]*

Edjalma Queiroz Silva, Celso Goncalves Camilo-Junior, Luiz Mario Lustosa Pascoal and Thierson Couto Rosa, Universidade Federal de Goias, Brazil

Recommendation systems work as a counselor, behaving in such a way to guide people in the discovery of products of interest. There are various techniques and approaches in the literature that enable generating recommendations. This is interesting because it emphasizes the diversity of options; on the other hand, it can cause doubt to the system designer about which is the best technique to use. Each of these approaches has particularities and depends on the context to be applied. Thus, the decision to choose among techniques become complex to be done manually. This article proposes an evolutionary approach for combining results of recommendation techniques in order to automate the choice of techniques and get fewer errors in recommendations. To evaluate the proposal, experiments were performed with a dataset from MovieLens and some of Collaborative Filtering techniques. The results show that the combining methodology proposed in this paper performs better than any one of collaborative filtering technique separately in the context addressed. The improvement varies from 9.02% to 48.21% depending on the technique and the experiment executed.

Tuesday, July 8, 4:00PM-6:00PM

Special Session: TuE2-1 Nature-Inspired Constrained Optimization

Tuesday, July 8, 4:00PM-6:00PM, Room: 203A, Chair: Helio Barbosa

4:00PM *Differential Evolution with a Species-Based Repair Strategy for Constrained Optimization [#E-14630]*

Chenyang Bu, Wenjian Luo and Tao Zhu, University of Science and Technology of China, China

Evolutionary Algorithms (EAs) with gradient-based repair, which utilize the gradient information of the constraints set, have been proved to be effective. It is known that it would be time-consuming if all infeasible individuals are repaired. Therefore, so far the infeasible individuals to be repaired are randomly selected from the population and the strategy of choosing individuals to be repaired has not been studied yet. In this paper, the Species-based Repair Strategy (SRS) is proposed to select representative infeasible individuals instead of the random selection for gradient-based repair. The proposed SRS strategy has been applied to eDEag which repairs the random selected individuals using the gradient-based repair. The new algorithm is named SRS-eDEag. Experimental results show that SRS-eDEag outperforms eDEag in most benchmarks. Meanwhile, the number of repaired individuals is reduced markedly.

4:20PM *Differential Evolution with Combined Variants for Dynamic Constrained Optimization [#E-14811]*

Maria-Yaneli Ameca-Alducin, Efren Mezura-Montes and Nicandro Cruz-Ramirez, University of Veracruz, Mexico

In this work a differential evolution algorithm is adapted to solve dynamic constrained optimization problems. The approach is based on a mechanism to detect changes in the objective function and/or the constraints of the problem so as to let the algorithm to promote the diversity in the population while pursuing the new feasible optimum. This is made by combining two popular differential evolution variants and using a memory of best solutions found during the search. Moreover, random-immigrants are added to the population at each generation and a simple hill-climber-based local search operator is applied to promote a faster convergence to the new feasible global optimum. The approach is compared against other recently proposed algorithms in an also recently proposed benchmark. The results show that the proposed algorithm provides a very competitive performance when solving different types of dynamic constrained optimization problems.

4:40PM *Solving Problems with a Mix of Hard and Soft Constraints Using Modified Infeasibility Driven Evolutionary Algorithm (IDEA-M) [#E-14042]*

Hemant Singh, Md. Asafuddoula and Tapabrata Ray, University of New South Wales, Australia

Most optimization problems in the field of engineering design involve constraints. These constraints are often due to statutory requirements (e.g. safety, physical laws, user requirements/functionality) and/or limits imposed on time and resources. Population based stochastic optimization algorithms are a preferred choice for solving design optimization problems due to their ability to deal with nonlinear black-box functions. Having a good constraint handling technique embedded within the algorithm is imperative for its good performance. With the final aim of achieving feasible optimum solutions, feasibility first techniques, i.e., those which prefer feasible solutions over infeasible, have been commonly used in the past. However, in recent studies more emphasis has been laid on intelligent use of infeasible solutions (instead of their indiscreet rejection) during the course of optimization; particularly because optimum solutions often lie on the constraint boundary. The preservation of good infeasible solutions in the population is likely to improve the convergence in constricted or disconnected feasible regions. In addition, it provides a set of marginally infeasible solutions for trade-off considerations. However, in the case of a problem consisting of a mix of hard (non-negotiable) and soft (negotiable) constraints, such trade-off solutions are practically useful if they violate the soft constraints only. In this paper, previously introduced Infeasibility Driven Evolutionary Algorithm (IDEA) is modified to deliver solutions which strictly satisfy the hard constraints and offer tradeoff solutions with respect to the soft constraints. The performance of the algorithm is demonstrated on three benchmark problems.

5:00PM *Differential Evolution with a Constraint Consensus Mutation for Solving Optimization Problems [#E-14527]*

Noha Hamza, Ruhul Sarker and Daryl Essam, University of New South Wales, Australia

in the literature, a considerable number of mutation operators have been proposed, which are the key search operators in differential evolution algorithm for solving optimization problems. Although those operators were developed in the context of unconstrained optimization, they were widely used in constrained optimization. However, those operators did not contain any mechanism that would reduce the constraint violation in the search process. Therefore, in this paper, a new mutation operator based on the constraint consensus method is proposed, which can help infeasible points reach the feasible region quickly. The algorithm is tested on the CEC2010 constrained benchmark problems. The experimental results show that the proposed algorithm is able to obtain better solutions in comparison with the state-of-the-art algorithms.

5:20PM *Constraint Handling in Agent-Based Optimization by Independent Sub-Swarms [#E-14115]*

Daniel Poole, Christian Allen and Thomas Rendall, University of Bristol, United Kingdom

Agent-based optimization algorithms are an effective means of solving global optimization problems with design spaces containing multiple local minima, however, modifications have to be made to such algorithms to be able to solve constrained optimization problems. The gravitational search algorithm (GSA) is an efficient and effective agent-based method, however, the idea of global transfer of data that is key to the algorithm's success prohibits coupling of many state-of-the-art methods for handling constraints. Hence, a robust method, called separation-sub-swarm (3S) has been developed specifically for use with GSA by exploiting but also accommodating the global transfer of data that occurs in GSA, however it can also act as an entirely black-box module so is generally applicable. This newly developed 3S method has been shown to be efficient and effective at optimizing a suite of constrained analytical test functions using GSA.

5:40PM *United Multi-Operator Evolutionary Algorithms [#E-14039]*

Saber Elsayed, Ruhul Sarker and Daryl Essam, University of New South Wales, Australia

Multi-method and multi-operator evolutionary algorithms (EAs) have shown superiority to any single EAs with a single operator. To further improve the performance of such algorithms, in this research study, a united multi-operator EAs framework is proposed, in which two EAs, each with multiple search operators, are used. During the evolution process, the algorithm emphasizes on the best performing multi-operator EA, as well as the search operator. The proposed algorithm is tested on a well-known set of constrained problems with 10D and 30D. The results show that the proposed algorithm scales well and is superior to the- state-of-the-art algorithms, especially for the 30D test problems

Special Session: TuE2-2 Computational Intelligence in Bioinformatics

Tuesday, July 8, 4:00PM-6:00PM, Room: 203B, Chair: Michael G. Epitropakis

4:00PM *A Memetic Hybrid Method for the Molecular Distance Geometry Problem with Incomplete Information [#E-14358]*

Marco S. Nobile, Andrea G. Citrolo, Paolo Cazzaniga, Daniela Besozzi and Giancarlo Mauri, University of Milano-Bicocca, Italy; University of Bergamo, Italy; University of Milano, Italy

The definition of computational methodologies for the inference of molecular structural information plays a relevant role in disciplines as drug discovery and metabolic engineering, since the functionality of a biochemical molecule is determined by its three-dimensional structure. In this work, we present an automatic methodology to solve the Molecular Distance Geometry Problem, that is, to determine the best three-dimensional shape that satisfies a given set of target inter-atomic distances. In particular, our method is designed to cope with incomplete distance information derived from Nuclear Magnetic Resonance measurements. To tackle this problem, that is known to be NP-hard, we present a memetic method that combines two soft-computing algorithms - Particle Swarm Optimization and Genetic Algorithms - with a local search approach, to improve the effectiveness of the crossover mechanism. We show the validity of our method on a set of reference molecules with a length ranging from 402 to 1003 atoms.

4:20PM *GAMI-CRM: Using De Novo Motif Inference to Detect Cis-Regulatory Modules [#E-14662]*

Jeffrey A. Thompson and Clare Bates Congdon, University of Southern Maine, United States

In this work, we extend GAMI (Genetic Algorithms for Motif Inference), a de novo motif inference system, to find sets of motifs that may function as part of a cis-regulatory module (CRM) using a comparative genomics approach. Evidence suggests that most transcription factors binding sites are part of a CRM, so our new approach is expected to yield stronger candidates for de novo inference of candidate regulatory elements and their combinatorial regulation of genes. Thanks to our genetic algorithms based approach, we are able to search relatively large input sequences (100,000nt or longer). Most current computational approaches to identifying candidate CRMs depend on foreknowledge of the processes that the genes they regulate are involved in. In comparison with one leading method, Cluster-Buster, our prototype de novo approach, which we call GAMI-CRM, performed well, suggesting that GAMI-CRM will be particularly useful in predicting CRMs for genes whose interactions are poorly understood.

4:40PM *An Immune Network Approach to Learning Qualitative Models of Biological Pathways [#E-14367]*

Wei Pang and George Coghill, University of Aberdeen, United Kingdom

In this paper we continue the research on learning qualitative differential equation (QDE) models of biological pathways building on previous work. In particular, we adapt opt- AiNet, an immune-inspired network approach, to effectively search the qualitative model space. To improve the performance of opt AiNet on the discrete search space, the hypermutation operator has been modified, and the affinity between two antibodies has been redefined. In addition, to accelerate the model verification process, we developed a more efficient Waltz-like inverse model checking algorithm. Finally, a Bayesian scoring function is incorporated into the fitness evaluation to better guide the search. Experimental results on learning the detoxification pathway of Methylglyoxal with various hypothesised hidden species validate the proposed approach, and indicate that our opt-AiNet based approach outperforms the previous CLONALG based approach on qualitative pathway identification.

5:00PM *Multi-Dimensional Scaling and MODELLER-Based Evolutionary Algorithms for Protein Model Refinement [#E-14461]*

Yan Chen, Yi Shang and Dong Xu, University of Missouri, United States

Protein structure prediction, i.e., computationally predicting the three-dimensional structure of a protein from its primary sequence, is one of the most important and challenging problems in bioinformatics. Model refinement is a key step in the prediction process, where improved structures are constructed based on a pool of initially generated models. Since the refinement category was added to the biennial Critical Assessment of Structure Prediction (CASP) in 2008, CASP results show that it is a challenge for existing model refinement methods to improve model quality consistently. This paper presents three evolutionary algorithms for protein model refinement, in which multidimensional scaling (MDS), the MODELLER software, and a hybrid of both are used as crossover operators, respectively. The MDS-based method takes a purely geometrical approach and generates a child model by combining the contact maps of multiple parents. The MODELLER-based method takes a statistical and energy minimization approach, and uses the remodeling module in MODELLER program to generate new models from multiple parents. The hybrid method first generates models using the MDS-based method and then run them through the MODELLER-based method, aiming at combining the strength of both. Promising results have been obtained in experiments using CASP datasets. The MDS-based method improved the best of a pool of predicted models in terms of the global distance test score (GDT-TS) in 9 out of 16 test targets.

5:20PM *A Modified Bat Algorithm to Predict Protein-Protein Interaction Network [#E-14617]*

Archana Chowdhury, Pratyusha Rakshit, Amit Konar and Atulya Nagar, Jadavpur University, India; Liverpool hope University, United Kingdom

This paper provides a novel approach to predict the Protein-Protein Interaction (PPI) network using a modified version of the Bat Algorithm. The attractive trait of the proposed approach is that it attempts to analyze the impact of physicochemical properties, structural features and evolutionary relationship of proteins, to predict the PPI network. Computer simulations reveal that our proposed method effectively predicts the PPI of Saccharomyces Cerevisiae with a sensitivity of (0.85) and specificity of (0.87) and outperforms other state-of-art methodologies.

5:40PM *Evolutionary Algorithms Applied to Likelihood Function Maximization During Poisson, Logistic, and Cox Proportional Hazards Regression Analysis [#E-14868]*

Leif Peterson, Houston Methodist Research Institute, United States

Metaheuristics based on genetic algorithms (GA), covariance matrix self-adaptation evolution strategies (CMSA-ES), particle swarm optimization (PSO), and ant colony optimization (ACO) were used for minimizing deviance for Poisson regression and maximizing the log-likelihood function for logistic regression and Cox proportional hazards regression. We observed that, in terms of regression coefficients, CMSA-ES and PSO metaheuristics were able to obtain solutions that were in better agreement with Newton-Raphson (NR) when compared with GA and ACO. The rate of convergence to the NR solution was also faster for CMSA-ES and PSO when compared with ACO and GA. Overall, CMSA-ES was the best-performing method used. Key factors which strongly influence performance are multicollinearity, shape of the log-likelihood gradient, and positive definiteness of the Hessian matrix.

Special Session: TuE2-3 Single Objective Numerical Optimization I

Tuesday, July 8, 4:00PM-6:00PM, Room: 203C, Chair: Qingfu Zhang and Bo Liu

4:00PM *A Surrogate-Assisted Differential Evolution Algorithm with Dynamic Parameters Selection for Solving Expensive Optimization Problems [#E-14280]*

Saber Elsayed, Tapabrata Ray and Ruhul Sarker, University of New South Wales, Australia

In this paper, a surrogate-assisted differential evolution (DE) algorithm is proposed to solve the computationally expensive optimization problems. In it, the Kriging model is used to approximate the objective function, while DE employs a mechanism to dynamically select the best performing combinations of parameters (amplification factor, crossover rate and population size). The performance of the algorithm is tested on the WCCI2014 competition on expensive single objective optimization problems. The experimental results demonstrate that the proposed algorithm has the ability to obtain good solutions.

4:20PM *A Hybrid Surrogate Based Algorithm (HSBA) to Solve Computationally Expensive Optimization Problems [#E-14371]*

Hemant Singh, Amitay Isaacs and Tapabrata Ray, University of New South Wales, Australia; IBM Australia, Australia

Engineering optimization problems often involve multiple objectives and constraints that are computed via computationally expensive numerical simulations. While the severe nonlinearity of the objective/constraint functions demand the use of population based searches (e.g. Evolutionary Algorithms), such algorithms are known to require numerous function evaluations prior to convergence and hence may not be viable in their native form. On the other hand, gradient based algorithms are fast and effective in identifying local optimum, but their performance is dependent on the starting point. In this paper, a hybrid algorithm is presented, which exploits the benefits offered by population based scheme, local search and also surrogate modeling to solve optimization problems with limited computational budget. The performance of the algorithm is reported on the benchmark problems designed for CEC 2014 Special Session and Competition on Single Objective Real-Parameter Numerical Optimization.

4:40PM *Evaluating the Performance of Group Counseling Optimizer on CEC 2014 Problems for Computational Expensive Optimization [#E-14543]*

Subhodip Biswas, Mohammad A. Eita, Swagatam Das and Athanasios V. Vasilakos, Jadavpur University, India; Egypt-Japan University of Science and Technology, Egypt; Indian Statistical Institute, India; Kuwait University, Kuwait

Group Counseling Optimizer (GCO) is a recently proposed population-based metaheuristics that simulates the ability of human beings to solve problems through counseling within a group and is motivated by the fact that the human thinking ability is often predicted to be the most rational. This research article examines the performance of GCO on the benchmark test suite designed for the CEC 2014 Competition for Computational Expensive Optimization. Experimental results on 24 black-box optimization problems (8 test problems with 10, 20 and 30 dimensions) have been tabulated along with the algorithm complexity metrics. Additionally we investigate the parametric behavior of GCO based on these test instances.

5:00PM *Solving the IEEE-CEC 2014 Expensive Optimization Test Problems by Using Single-Particle MVMO [#E-14616]*

Istvan Erlich, Jose L. Rueda and Sebastian Wildenhues, University Duisburg-Essen, Germany

Mean-Variance Mapping Optimization (MVMO) constitutes an emerging heuristic optimization algorithm, whose evolutionary mechanism adopts a single parent-offspring pair approach along with a normalized range of the search space for all optimization variables. Besides, MVMO is characterized by an archive of n-best solutions from which the unique mapping function defined by the mean and variance of the optimization variables is derived. The algorithm proceeds by projecting randomly selected variables onto the corresponding mapping function that guides the solution towards the best set achieved so far. Despite the orientation on the best solution the algorithm keeps on searching globally. This paper provides an evaluation of the performance of MVMO when applied for the solution of computationally expensive optimization problems. Experimental tests, conducted on the IEEE-CEC 2014 optimization test bed, highlight the capability of the MVMO to successfully tackle different complex problems within a reduced number of allowed function evaluations.

5:20PM *SO-MODS: Optimization for High Dimensional Computationally Expensive Multi-Modal Functions with Surrogate Search [#E-14756]*

Tipaluck Krityakierne, Juliane Mueller and Christine Shoemaker, Cornell University, United States

SO-MODS is a new algorithm that combines surrogate global optimization methods with local search. SO-MODS is an extension of prior algorithms that sought to find near optimal solutions for computationally very expensive functions for which the number of allowable evaluations is strictly limited. The global search method in SO-MODS perturbs the best point found so far in order to find a new sample point. The number of decision variables being perturbed is dynamically adjusted in each iteration in order to be more effective for higher dimensional problems. The procedure for dynamically changing the dimensions perturbed is drawn from earlier work on the DYCORS algorithm. We use a cubic radial basis function as surrogate model and investigate two approaches to improve the solution accuracy. The numerical results show that SO-MODS is able to reduce the objective function value dramatically with just a few hundred evaluations even for 30-dimensional problems. The local search is then able to reduce the objective function value further.

Special Session: TuE2-4 Data Mining and Machine Learning Meet Evolutionary Computation

Tuesday, July 8, 4:00PM-6:00PM, Room: 203D, Chair: Zhun Fan

4:00PM *An Evolutionary Multi-Objective Approach for Prototype Generation [#E-14253]*

Alejandro Rosales-Perez, Hugo Jair Escalante, Carlos A. Coello Coello, Jesus A. Gonzalez and Carlos A. Reyes-Garcia, INAOE, Mexico; CINVESTAV-IPN, Mexico

k-NN is one of the most popular and effective models for pattern classification. However, it has two main drawbacks that hinder the application of this method for large data sets: (1) the whole training set has to be stored in memory, and (2) for classifying a test pattern it has to be compared to all other training instances. In order to overcome these shortcomings, prototype generation (PG) methods aim to reduce the size of the training set while maintaining or increasing the classification performance of k-NN. Accordingly, most PG methods aim to generate instances that try to maximize classification performance. Nevertheless, in most cases, the reduction objective is only implicitly optimized. This paper introduces EMOPG, a novel approach to PG based on multi-objective optimization that explicitly optimizes both objectives: accuracy and reduction. Under EMOPG, prototypes are initialized with a subset of training instances selected through a tournament, according to a weighting term. A multi-objective evolutionary algorithm, PAES (Pareto Archived Evolution Strategy), is implemented to adjust the position of the initial prototypes. The optimization process aims to simultaneously maximize the classification performance of prototypes while reducing the number of instances with respect to the training set. A strategy for selecting a single solution from the set of non-dominated solutions is proposed. We evaluate the performance of EMOPG using a suite of benchmark data sets and compare the performance of our proposal with respect to the one obtained by alternative techniques. Experimental results show that our proposed method offers a better trade-off between accuracy and reduction than other methods.

4:20PM *Use EMO to Protect Sensitive Knowledge in Association Rule Mining by Removing Items [#E-14655]*

Peng Cheng, Jeng-Shyang Pan and Chun-Wei Lin, Harbin Institute of Technology, China

When people utilize data mining techniques to discover useful knowledge behind large database; they also have the requirement to preserve some information so as not to be mined out, such as sensitive frequent item sets, rules, classification tree and the like. A feasible way to address this problem is to sanitize the database to conceal sensitive information. In this paper, we focus on privacy preserving in association rule mining. In light of the tradeoff between hiding sensitive rules and disclosing non-sensitive ones during hiding process, we tackle this problem from a point view of multi-objective optimization. A novel association rule hiding approach was proposed based on evolutionary multi-objective optimization (EMO) algorithm. It adopted the model of hiding sensitive rules by deleting some transactions in database. Three side effects, including sensitive rules not hidden, non-sensitive lost rules and spurious rules were formulated as objectives to be minimized. EMO algorithm is utilized to find a suitable subset of transactions to remove so that the three side effects are minimized. Experiment results were reported to show the effectiveness of the proposed approach.

4:40PM *An Online Evolutionary Rule Learning Algorithm with Incremental Attribute Discretization [#E-14803]*

Essam Debie, Kamran Shafi, Kathryn Merrick and Chris Lokan, University of New South Wales/Australian Defence Force Academy, Australia

Classification rule induction involves two main processes: finding the optimal conjuncts (attribute intervals or attribute-value pairs) and their combination (disjuncts or rules) to classify different concepts in the data. The evolutionary rule learning approaches employ an evolutionary algorithm, such as a genetic algorithm, to perform both these search operations simultaneously. This approach often leads to significant problems including population bloating and stalled evolutionary search in real-valued attribute problems, especially with higher dimensions. In this paper, we present an online evolutionary rule learning approach referred to as ERL-AID that decouples the above search processes and employs a discretization algorithm that works on the attribute space and a genetic algorithm to combine the discretized attributes into appropriate classification rules. ERL-AID applies a sliding window approach to process inputs in an online fashion. The proposed system is able to produce compact rule sets with competitive performance and could scale to higher dimensions. The experimental results show the competitiveness of our algorithm.

5:00PM *An External Archive Guided Multiobjective Evolutionary Approach Based on Decomposition for Continuous Optimization [#E-14257]*

Yexing Li, Xinye Cai, Zhun Fan and Qingfu Zhang, Nanjing University of Aeronautics and Astronautics, China; Shantou University, China; University of Essex, United Kingdom

In this paper, we propose a decomposition based multiobjective evolutionary algorithm that extracts information from an external archive to guide the evolutionary search for continuous optimization problem. The proposed algorithm used a mechanism to identify the promising regions(subproblems) through learning information from the external archive to guide evolutionary search process. In order to demonstrate the performance of the algorithm, we conduct experiments to compare it with other decomposition based approaches. The results validate that our proposed algorithm is very competitive.

5:20PM *Multi-Objective Differential Evolution with Leadership Enhancement (MODEL) [#E-14745]*

Farid Bourennani, Shahryar Rahnamayan and Greg F. Naterer, University of Ontario Institute of Technology, Canada; Memorial University of Newfoundland, Canada

Differential Evolution (DE) has been successfully used to solve various complex optimization problems; however, it can suffer depending of the complexity of the problem from slow convergence due to its iterative process. The use of the leadership concept was efficiently utilized for the acceleration of Particle Swarm Optimization (PSO) in a single-objective space. The generalization of the leadership concept in multi-objective space is not trivial. Furthermore, despite the efficiency of using the leadership concept, a limited number of multi-objective metaheuristics utilize it. To address these challenges, this paper incorporates the concept of leadership in a multi-objective variant of DE by introducing it into the mutation scheme. The preliminary results are promising as MODEL outperformed the parent algorithm GDE3 and showed the highest accuracy when compared with seven other algorithms.

5:40PM *On the Performance of Classification Algorithms for Learning Pareto-Dominance Relations [#E-14842]*

Sunith Bandaru, Amos Ng and Kalyanmoy Deb, University of Skovde, Sweden; Michigan State University, United States

Multi-objective evolutionary algorithms (MOEAs) are often criticized for their high-computational costs. This becomes especially relevant in simulation-based optimization where the objectives lack a closed form and are expensive to evaluate. Over the years, meta-modeling or surrogate modeling techniques have been used to build inexpensive approximations of the objective functions which reduce the overall number of function evaluations (simulations). Some recent studies however, have pointed out that accurate models of the objective functions may not be required at all since evolutionary algorithms only rely on the relative ranking of candidate solutions. Extending this notion to MOEAs, algorithms which can 'learn' Paretodominance relations can be used to compare candidate solutions under multiple objectives. With this goal in mind, in this paper, we study the performance of ten different off-the-shelf classification algorithms for learning Pareto-dominance relations in the ZDT test suite of benchmark problems. We

consider prediction accuracy and training time as performance measures with respect to dimensionality and skewness of the training data. Being a preliminary study, this paper does not include results of integrating the classifiers into the search process of MOEAs.

Wednesday, July 9, 1:30PM-3:30PM

WeE1-1 Multi-Objective Evolutionary Algorithms I

Wednesday, July 9, 1:30PM-3:30PM, Room: 203A, Chair: Kalyanmoy Deb

1:30PM *A Review of Hybrid Evolutionary Multiple Criteria Decision Making Methods [#E-14319]*

Robin Purshouse, Kalyanmoy Deb, Maszatul M. Mansor, Sanaz Mostaghim and Rui Wang, University of Sheffield, United Kingdom; Michigan State University, United States; Otto von Guericke University Magdeburg, Germany; National University of Defense Technology, China

For real-world problems, the task of decision-makers is to identify a solution that can satisfy a set of performance criteria, which are often in conflict with each other. Multi-objective evolutionary algorithms tend to focus on obtaining a family of solutions that represent the trade-offs between the criteria; however ultimately a single solution must be selected. This need has driven a requirement to incorporate decision-maker preference models into such algorithms - a technique that is very common in the wider field of multiple criteria decision making. This paper reviews techniques which have combined evolutionary multi-objective optimization and multiple criteria decision making. Three classes of hybrid techniques are presented: a posteriori, a priori, and interactive, including methods used to model the decision-makers preferences and example algorithms for each category. To encourage future research directions, a commentary on the remaining issues within this research area is also provided.

1:50PM *MOEA/D with Tabu Search for Multiobjective Permutation Flow Shop Scheduling Problems [#E-14406]*

Ahmad Alhindi and Qingfu Zhang, University of Essex, United Kingdom

Multiobjective Evolutionary Algorithm based on Decomposition (MOEA/D) decomposes a multiobjective optimisation problem into a number of single-objective problem and optimises them in a collaborative manner. This paper investigates how to use Tabu Search (TS), a well-studied single objective heuristic to enhance MOEA/D performance. In our proposed approach, the TS applies to these subproblems with the aim to escape from local optimal solutions. The experimental studies have shown that MOEA/D with TS outperforms the classical MOEA/D on multiobjective permutation flow shop scheduling problems. It also have demonstrated that use of problem specific knowledge can significantly improve the algorithm performance.

2:10PM *Online Objective Reduction for Many-Objective Optimization Problems [#E-14670]*

Yiu-ming Cheung and Fangqing Gu, Hong Kong Baptist University, Hong Kong

For many-objective optimization problems, i.e. the number of objectives is greater than three, the performance of most of the existing Evolutionary Multi-objective Optimization algorithms will deteriorate to a certain degree. It is therefore desirable to reduce many objectives to fewer essential objectives, if applicable. Currently, most of the existing objective reduction methods are based on objective selection, whose computational process is, however, laborious. In this paper, we will propose an online objective reduction method based on objective extraction for the many-objective optimization problems. It formulates the essential objective as a linear combination of the original objectives with the combination weights determined based on the correlations of each pair of the essential objectives. Subsequently, we will integrate it into NSGA-II. Numerical studies have show the efficacy of the proposed approach.

2:30PM *Diversity Preservation with Hybrid Recombination for Evolutionary Multiobjective Optimization [#E-14788]*

Sen Bong Gee and Kay Chen Tan, National University of Singapore, Singapore

Convergence and diversity are two crucial issues in evolutionary multiobjective optimization. To enhance the diversity property of Multiobjective Evolutionary Algorithm (MOEA), a novel selection method is implemented on decomposition-based MOEA (MOEA/D). The selection method incorporates the concept of maximum diversity loss, which quantifies the diversity loss of each individual in every generation. By monitoring tolerance of the diversity loss, the diversity of the solutions in each generation can be preserved. To further enhance the algorithm's search ability, a new hybrid recombination strategy is implemented by taking the advantage of different recombination operator. In terms of Inverted Generational Distance (IGD), the experiment results shown that the proposed algorithm, namely DHRSMOEA/D, performed significantly better than many state-of-the-art MOEAs in most of the CEC-09 and WFG test problems.

2:50PM *An Evolutionary Approach to the Solution of Multi-Objective Min-Max Problems in Evidence-Based Robust Optimization [#E-14148]*

Simone Alicino and Massimiliano Vasile, University of Strathclyde, United Kingdom

This paper presents an evolutionary approach to solve the multi-objective min-max problem (MOMMP) that derives from the maximization of the Belief in robust design optimization. In evidence-based robust optimization, the solutions that minimize the design budgets are robust under epistemic uncertainty if they maximize the Belief in the realization of the value of the design budgets. Thus robust solutions are found by minimizing, with respect to the design variables, the global maximum with respect to the uncertain variables. This paper presents an algorithm to solve MOMMP, and a computational cost reduction technique based on Kriging metamodels. The results show that the algorithm is able to accurately approximate the Pareto front for a MOMMP at a fraction of the computational cost of an exact calculation.

3:10PM *Kriging Model Based Many-Objective Optimization with Efficient Calculation of Expected Hypervolume Improvement [#E-14178]*

Chang Luo, Koji Shimoyama and Shigeru Obayashi, Tohoku University, Japan

The many-objective optimization performance of using expected hypervolume improvement (EHVI) as the updating criterion of Kriging surrogate model is investigated, and compared with those of using expected improvement (EI) and estimation (EST) updating criteria in this paper. An exact algorithm to calculate hypervolume is used for the problems with less than six objectives. On the other hand, in order to improve the efficiency of hypervolume calculation, an approximate algorithm to calculate hypervolume based on Monte Carlo sampling is adopted for the problems with more objectives. Numerical experiments are conducted in 3 to 12-objective DTLZ1, DTLZ2, DTLZ3 and DTLZ4 problems. The results show that, in DTLZ3 problem, EHVI always obtains better convergence and diversity performances than EI and EST for any number of objectives. In DTLZ2 and DTLZ4 problems, the advantage of EHVI is shown gradually as the number of objectives increases. The present results suggest that EHVI will be a highly competitive updating criterion for the many-objective optimization with Kriging model.

WeE1-2 Evolutionary Games and Multi-Agent Systems

Wednesday, July 9, 1:30PM-3:30PM, Room: 203B, Chair: Hussein Abbass

1:30PM *Effects of Ensemble Action Selection on the Evolution of Iterated Prisoner's Dilemma Game Strategies [#E-14844]*

Takahiko Sudo, Yusuke Nojima and Hisao Ishibuchi, Osaka Prefecture University, Japan

Iterated prisoner's dilemma (IPD) games have been frequently used for examining the evolution of cooperative game strategies. It has been pointed out in some studies that the choice of a representation scheme (i.e., coding mechanism) has a large effect on the evolution. A choice of a different representation scheme often leads to totally different results. In those studies on IPD games, a single representation scheme is assigned to all players. That is, all players have the same representation scheme. In our former studies, we reported experimental results in an inhomogeneous setting where a different representation scheme was assigned to each player. The evolution of cooperation among different types of game strategies was examined. In this paper, we report experimental results in another interesting setting where each player is assumed to have multiple strategies with different representation schemes. The next action of each player is determined by a majority vote by its strategies. That is, each player is assumed to have an ensemble decision making system. Experimental results in such an ensemble IPD model are compared with those in the standard IPD model where each player has a single strategy.

1:50PM *The Structure of a Probabilistic 2-State Finite Transducer Representation for Prisoner's Dilemma [#E-14849]*

Jeffrey Tsang, University of Guelph, Canada

Several studies have used the fingerprint, a mathematical technique that generates a representation-independent functional signature of a game playing strategy, to conduct automated analyses of spaces of strategies. This study looks at an even larger state space, namely a grid over the probabilistic 2-state finite transducers, as a representation for playing Prisoner's Dilemma. Even using just a three-level {0, 0.5, 1} grid amounts to 100,000 representable strategies, with an immense 40,679 unique strategies within. All strategies are fingerprinted and all pairwise distances computed, then hierarchical clustering reduces this dataset to around size 10,000 for further analysis with multidimensional scaling. Results indicate that the 20-dimensional grid has no obvious cutoff scales of structure, that we can quantify several important dimensions, and a high level of similarity with past results on smaller state spaces. We also find an interesting difference between complete playing equivalence of deterministic versus probabilistic transducers.

2:10PM *Competitive Coevolutionary Training of Simple Soccer Agents from Zero Knowledge [#E-14037]*

Christiaan Scheepers and Andries Engelbrecht, University of Pretoria, South Africa

A new competitive coevolutionary team-based particle swarm optimisation (CCPSO) algorithm is developed to train multi-agent teams from zero knowledge. The CCPSO algorithm uses the charged particle swarm optimiser to train neural network controllers for simple soccer agents. The training performance of the CCPSO algorithm is analysed. The analysis identifies a critical weakness of the CCPSO algorithm in the form of outliers in the measured performance of the trained players. A hypothesis is presented that explains the presence of the outliers, followed by a detailed discussion of various biased and unbiased relative fitness functions. A new relative fitness function based on FIFA's league ranking system is presented. The performance of the unbiased relative fitness functions is evaluated and discussed. The final results show that the FIFA league ranking relative fitness function outperforms the other unbiased relative fitness functions, leading to consistent training results.

2:30PM *Online Generation of Trajectories for Autonomous Vehicles Using a Multi-Agent System [#E-14265]*

Garrison Greenwood, Saber Elsayed, Ruhul Sarker and Hussein Abbass, Portland State University, United States; University of New South Wales, Australia

Autonomous vehicles are frequently deployed in environments where only certain trajectories are feasible. Clas- sical trajectory generation methods attempt to find a feasible trajectory that satisfies a set of constraints. In some cases the optimal trajectory may be known, but it is hidden from the autonomous vehicle. Under such circumstance the vehicle must discover a feasible trajectory. This paper describes a multi-agent system that uses a combination of reinforcement learning and differential evolution to generate a trajectory that is epsilon-close to a target trajectory that is hidden.

2:50PM *A Cooperative Coevolutionary Approach to Multi-Robot Formation Control [#E-14274]*

Seung-Mok Lee and Hyun Myung, Korea Advanced Institute of Science and Technology, Korea, Republic of

This paper proposes a cooperative coevolutionary approach to multi-robot formation control. To deal with the formation control problem, the concept of a cooperative coevolution (CC) framework is incorporated with model predictive control (MPC) such that candidates of all robots coevolve toward a Nash equilibrium in a distributed way. Using the Nash-equilibrium strategy, the robots can quickly move to a desired formation from their initial locations. The stability is guaranteed via a novel repair algorithm that enforces each candidate to satisfy a derived condition for asymptotic stability. The cooperative coevolutionary particle swarm optimization (CCPSO) is adopted and modified to fit into the formation control problem. Simulations are performed on a group of nonholonomic mobile robots to demonstrate the effectiveness of the CC-based MPC. Also, the proposed MPC shows a better performance compared to sequential quadratic programming (SQP)-based MPC.

3:10PM *Graph Centrality Measures and the Robustness of Cooperation [#E-14737]*

Menglin Li and Colm O'Riordan, NUI Galway, Ireland

Previous research shows that for structured populations located on a graph, one of the most important attributes that can decide whether a cooperative community is robust is the topology of the graph. However, even in a graph which is highly robust with respect to cooperation, ``weak points'' may still exist which will allow the defection to spread quickly in the community. Previous work shows that the transitivity and the average degree are related to the robustness of the cooperation in the entire graph. In addition to considering the cooperation across the entire graph, whether an individual in the graph will allow the spread of defection is an important research question in its own right. In this work, we are trying to identify both the ``weak'' individuals and the the ``robust'' ones. We measure the centrality in the graph together with the the degree, the local clustering coefficient, the betweenness, the closeness, the degree eigenvector, and a few new designed centrality measures such as ``clustering eigenvector centrality''. The results show that for graphs that have a fixed number of vertices and edges, there are both robust individuals and weak individuals and that the higher the transitivity of the graph, the more robust the individuals are in the graph. However,

although some of the graph centrality measures may indicate whether a vertex is robust or not, the prediction is still quite unstable.

Special Session: WeE1-3 Hybrid Evolutionary Computational Methods for Complex Optimization Problems

Wednesday, July 9, 1:30PM-3:30PM, Room: 203C, Chair: Kit Yan Chan

1:30PM *Non-Invasive Detection of Hypoglycemic Episodes in Type1 Diabetes Using Intelligent Hybrid Rough Neural System [#E-14021]*

Sai Ho Ling, Phyo Phyo San, Hak Keung Lam and Hung Nguyen, University of Technology System, Australia; King's College London, United Kingdom

Insulin-dependent diabetes mellitus is classified as Type 1 diabetes and it can be further classified as immune-mediated or idiopathic. Through the analysis of electrocardiographic (ECG) signals of 15 children with T1DM, an effective hypoglycemia detection system, hybrid rough set based neural network (RNN) is developed by the use of physiological parameters of ECG signal. In order to detect the status of hypoglycemia, the feature of ECG of type 1 diabetics are extracted and classified according to corresponding glucose levels. In this technique, the applied physiological inputs are partitioned into predicted (certain) or random (uncertain) parts using defined lower and boundary of rough regions. In this way, the neural network is designed to deal only with the boundary region which mainly consists of a random part of applied input signal causing inaccurate modeling of the data set. A global training algorithm, hybrid particle swarm optimization with wavelet mutation (HPSOWM) is introduced for parameter optimization of proposed RNN. The experiment is carried out using real data collected at Department of Health, Government of Western Australia. It indicated that the proposed hybrid architecture is efficient for hypoglycemia detection by achieving better sensitivity and specificity with less number of design parameters.

1:50PM *Image Deblurring Using a Hybrid Optimization Algorithm [#E-14105]*

Kit Yan Chan, N. Rajakaruna, C. Rathnayake and I. Murray, Curtin University, Australia

In many applications, such as way finding and navigation, the quality of image sequences are generally poor, as motion blur caused from body movement degrades image quality. It is difficult to remove the blurs without prior information about the camera motion. In this paper, we utilize inertial sensors, including accelerometers and gyroscopes, installed in smartphones, in order to determine geometric data of camera motion during exposure. Based on the geometric data, we derive a blurring function namely point spread function (PSF) which deblur the captured image by reversing motion effect. However, determination of the optimal PSF with respect to the image quality is multioptimum, as deblurred images are not linearly correlated to image intelligibility. Therefore, this paper proposes a hybrid optimization method, which is, incorporated the mechanisms of particle swarm optimization (PSO) and gradient search method, in order to optimize PSF parameters. It aims to incorporate the advantages of the two methods, where the PSO is effective in localizing the global region and the gradient search method is effective in converging local optimum. Experimental results indicated that deblurring can be successfully performed using the optimal PSF. Also, the performance of proposed method is compared with the commonly used deblurring methods. Better results in term of image quality can be achieved. The resulting deblurring methodology is an important component. It will be used to improve deblurred images to perform edge detection, in order to detect paths, stairs ways, movable and immovable objects for vision-impaired people.

2:10PM *An Algorithm for Scalable Clustering: Ensemble Rapid Centroid Estimation [#E-14159]*

Mitchell Yuwono, Steven W. Su, Bruce D. Moulton, Ying Guo and Hung T. Nguyen, University of Technology Sydney, Australia; Commonwealth Scientific and Industrial Research Organisation, Australia

This paper describes a new algorithm, called Ensemble Rapid Centroid Estimation (ERCE), designed to handle large-scale non-convex cluster optimization tasks, and estimate the number of clusters with quasi-linear complexity. ERCE stems from a recently developed Rapid Centroid Estimation (RCE) algorithm. RCE was originally developed as a lightweight simplification of the Particle Swarm Clustering (PSC) algorithm. RCE retained the quality of PSC, greatly reduced the computational complexity, and increased the stability. However, RCE has certain limitations with respect to complexity, and is unsuitable for non-convex clusters. The new ERCE algorithm presented here addresses these limitations.

2:30PM *Evolutionary Regional Network Modeling for Efficient Engineering Optimization [#E-14164]*

Jyh-Cheng Yu and Zhi-Fu Liang, National Kaohsiung First University of Science and Technology, Taiwan

This study presents a soft computing based optimization methodology, the evolutionary regional neural network modeling for engineering applications with sampling constraints. Engineering optimization often involves expensive experiment costs. Intelligent optimization advocates establishing a neural network model using small training samples such as orthogonal array to set up a surrogate model for the engineering system followed by an optimum search in the model to reduce optimization cost. However, scarce training samples might compromise modeling generality for a complex problem. Empirical rules suggest reliable predictions are likely restricted to the neighboring space of training samples, and interpolating designs are more reliable than extrapolating designs. To avoid imperfection of model due to small learning samples, an evolutionary regional network model is set up to confine the search of quasi- optimum using genetic algorithm. The constrained search in the regional network model provides a reliable quasi-optimum. The verification of the optimum is added to the learning samples to retrain the regional network model while the size and the distribution of reliable space will evolve intelligently during the optimization iteration using a fuzzy inference according to the prediction accuracy. An engineering case study, the optimal die gap parison programming of extrusion blow molding process for a uniform thickness, is presented to demonstrate the robustness and efficiency of the proposed methodology.

2:50PM *Quantum Bacterial Foraging Optimization Algorithm [#E-14024]*

Fei Li, Yuting Zhang and Haibo Li, Nanjing University of Posts and Telecommunications, China; Umea University, Sweden

This paper proposes a novel swarm intelligence optimization method which integrates bacterial foraging optimization (BFO) with quantum computing, called quantum bacterial foraging optimization (QBFO) algorithm. In QBFO, a multi-qubit which can represent a linear superposition of states in search space probabilistically is used to represent a bacterium, so that the quantum bacteria representation has a better characteristic of population diversity. A quantum rotation gate is designed to simulate the chemotactic step to drive the bacteria toward better solutions. Several tests are conducted based on benchmark functions including multi-peak function to evaluate optimization performance of the proposed algorithm. The numeric results show that the

proposed QBFO has more powerful properties in convergence rate, stability and the ability of searching for the global optimal solution than the original BFO and quantum genetic algorithm. In addition, we applied our proposed QBFO to solve the traveling salesman problem, which is a well-known NP-hard problem in combinatorial optimization. The results indicate that the proposed QBFO shows better convergence behavior without premature convergence, and has more powerful properties in convergence rate, stability and the ability of searching for the global optimal solution, as compared to ant colony optimization algorithm and quantum genetic algorithm.

3:10PM *A Cultural Algorithm for Spatial Forest Harvest Scheduling [#E-14447]*

Wan-Yu Liu and Chun-Cheng Lin, Aletheia University, Taiwan; National Chiao Tung University, Taiwan

This paper proposes a cultural algorithm for the spatial forest harvest scheduling for maximizing the total harvested timber volume, under the constraints of minimum harvest age, minimum adjacency green-up age, and approximately even volume flow for each period of the schedule. In order to increase the solution-search ability, the cultural algorithm extracts problem-specific information during the evolutionary solution search to update the belief space of a generation, which has cultural influences and guidance on the next generation. The key design of our cultural algorithm is to propose the cultural and evolutionary operators specifically for the problem. Experimental analysis shows that our cultural algorithm performs better than the previous approaches.

Special Session: WeE1-4 Large Scale Global Optimization

Wednesday, July 9, 1:30PM-3:30PM, Room: 203D, Chair: Xiaodong Li

1:30PM *A Hybrid Adaptive Coevolutionary Differential Evolution Algorithm for Large-Scale Optimization [#E-14092]*

Sishi Ye, Guangming Dai and Lei Peng, China University of Geosciences (Wuhan), China

In this paper, we propose a new algorithm, named HACC-D, for large scale optimization problems. The motivation is to improve the optimization method for the subcomponents in the cooperative coevolution framework. In the new HACC-D algorithm, an algorithm selection method named hybrid adaptive optimization strategy is used. It is aimed to hybridize the superiority of two very efficient differential evolution algorithms, JADE and SaNSDE, as the subcomponent optimization algorithm of the cooperative coevolution. In the beginning stage, the novel strategy evolves the initial population with JADE and SaNSDE as the subcomponent optimization algorithm for a certain number of iterations separately. Then the one obtained better fitness value will be chosen to be the subcomponent optimization algorithm for the following evolution process. In the later stage of evolution, the selected algorithm may be trapped in a local optimum or lose its ability to make further progress. So it exchanges the subcomponent optimization algorithm with the other one when there is no improvement in the fitness every certain number of iterations. The proposed HACC-D algorithm is evaluated on CEC'2010 benchmark functions for large scale global optimization.

1:50PM *Cooperative Co-Evolution with a New Decomposition Method for Large-Scale Optimization [#E-14241]*

Sedigheh Mahdavi, Mohammad Ebrahim Shiri and Shahryar Rahnamayan, Amirkabir University of Technology, Iran; University of Ontario Institute of Technology, Canada

Cooperative Co-evolutionary algorithms are effective approaches to solve large-scale optimization problems. The crucial challenge in these methods is the design of a decomposition method which is able to detect interactions among variables. In this paper, we proposed a decomposition method based on High Dimensional Model Representation (HDMR) which extracts separable and nonseparable subcomponents for Cooperative Co-evolutionary algorithms. The entire decomposition procedure is conducted before applying the optimization. The experimental results for D=1000 on twenty CEC-2010 benchmark functions show that the proposed method is promisingly efficient to solve large-scale optimization problems. The proposed approach is compared with two other methods and discussed in details.

2:10PM *Variable Grouping Based Differential Evolution Using an Auxiliary Function for Large Scale Global Optimization [#E-14278]*

Fei Wei, Yuping Wang and Tingting Zong, Xidian University, China

Evolutionary algorithms (EAs) are a kind of efficient and effective algorithms for global optimization problems. However, their efficiency and effectiveness will be greatly reduced for large scale problems. To handle this issue, a variable grouping strategy is first designed, in which the variables with the interaction each other are classified into one group, while the variables without interaction are classified into different groups. Then, evolution can be conducted in these groups separately. In this way, a large scale problem can be decomposed into several small scale problems and this makes the problem solving much easier. Furthermore, an auxiliary function, which can help algorithm to escape from the current local optimal solution and find a better one, is designed and integrated into EA. Based on these, variable grouping based differential evolution (briefly, VGDE)using auxiliary function is proposed. At last, the simulations are made on the standard benchmark suite in CEC'2013, and VGDE is compared with several well performed algorithms. The results indicate the proposed algorithm VGDE is more efficient and effective.

2:30PM *Solving Dynamic Double-Row Layout Problem via an Improved Simulated Annealing Algorithm [#E-14282]*

Shengli Wang, Xingquan Zuo and Xinchao Zhao, Beijing University of Posts and Telecommunications, China

Double-row layout problem (DRLP) is a new problem proposed in 2010. Different from single or multi-row layout problems, DRLP needs to determine not only the sequence of machines on both rows but also the exact location of each machine. Aiming at the dynamic environment of product processing in practice, in this paper we study DRLP under dynamic environment and propose a dynamic double-row layout problem (DDRLP) where the material flows may change over time. A mixed-integer programming model is established for the DDRLP. An improved simulated annealing (ISA) algorithm is proposed to for this problem. To represent a feasible solution, a mixed coding scheme is suggested to express the sequence of facilities and the exact location of each facility. Five operators are devised to make the ISA able to effectively solve this problem. Experiment results show that the proposed algorithm is able to find the optimal solutions for small size problem instances and outperform an exact approach (CPLEX) under limited run time for large size instances.

2:50PM *Effective Decomposition of Large-Scale Separable Continuous Functions for Cooperative Co-Evolutionary Algorithms [#E-14420]*
Mohammad Nabi Omidvar, Yi Mei and Xiaodong Li, RMIT University, Australia

In this paper we investigate the performance of cooperative co-evolutionary (CC) algorithms on large-scale fully-separable continuous optimization problems. We have shown that decomposition can have significant impact on the performance of CC algorithms. The empirical results show that the subcomponent size should be chosen small enough so that the subcomponent size is within the capacity of the subcomponent optimizer. In practice, determining the optimal size is difficult. Therefore, adaptive techniques are desired by practitioners. Here we propose an adaptive method, MLSoft, that uses widely-used techniques in reinforcement learning such as the value function method and softmax selection rule to adapt the subcomponent size during the optimization process. The experimental results show that MLSoft is significantly better than an existing adaptive algorithm called MLCC on a set of large-scale fully-separable problems.

3:10PM *Variable Neighborhood Decomposition for Large Scale Capacitated Arc Routing Problem [#E-14191]*
Yi Mei, Xiaodong Li and Xin Yao, RMIT University, Australia; University of Birmingham, United Kingdom

In this paper, a Variable Neighborhood Decomposition (VND) is proposed for Large Scale Capacitated Arc Routing Problems (LSCARP). The VND employs the Route Distance Grouping (RDG) scheme, which is a competitive decomposition scheme for LSCARP, and generates different neighborhood structures with different tradeoffs between exploration and exploitation. The search first uses a neighborhood structure that is considered to be the most promising, and then broadens the neighborhood gradually as it is getting stuck in a local optimum. The experimental studies show that the VND performed better than the state-of-the-art RDG-MAENS counterpart, and the improvement is more significant when the subcomponent size is smaller. This implies a great potential of combining the VND with small subcomponents.

WeI1-1 Intel Special Session on Big Data Analytics

Wednesday, July 9, 1:30PM-3:30PM, Room: 311A, Chair: Catherine Huang

1:30PM *Practice in Analyzing Corporate Textual Data*
Phil Tian, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

1:50PM *Intel Hadoop and Its Use Cases*
Keith Qi, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:10PM *Big Data Foundation Platform for Video Analytics*
Albert Hu, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:30PM *Cloud based Air Quality Monitoring at Scale*
Fred Jiang, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

2:50PM *Big Data Foundation Platform for Video Analytics Demo*
Albert Hu, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

3:10PM *Cloud based Air Quality Monitoring at Scale Demo*
Fred Jiang, Intel Corporation, China

This presentation is part of the Intel special session on big data analytics and demo, which contains a collection of works from Intel. The goal of this special session is to show connections and real-world applications of CI in industry.

Wednesday, July 9, 3:30PM-6:00PM

Poster Session: PE3 Poster Session III

Wednesday, July 9, 3:30PM-6:00PM, Room: Posters Area (Level 2), Chair: Tadahiko Murata

P501 *A New Dynamic Probabilistic Particle Swarm Optimization with Dynamic Random Population Topology [#E-14349]*
Qingjian Ni, Cen Cao and Xushan Yin, Southeast University, China

Population topologies of Particle Swarm Optimization algorithm (PSO) have direct impacts on the information sharing amony particles during the evolution, and will influence the PSO algorithms' performance obviously. The canonical PSO algorithms usually use static population topologies, and the majority are the classic population topologies (such as fully connected topology and ring topology). In this paper, we present the strategies of dynamic random topology based on the random generation of population topologies. The basic idea is as follows: various random topologies are used at different stages of evolution in the population, and the solving performance of PSO algorithms is enhanced by improving the information exchange of population in different evolutionary stages. This provides a new way of thinking for the improvement of the PSO algorithm. Experimental results on a relatively new variant of dynamic probabilistic particle swarm optimization show that our strategies can achieve better performance compared with traditional static population topologies. Experimental data are analyzed and discussed in the paper, and the useful conclusions will provide a basis for further research.

P502 *An Adaptive PSO Based on Motivation Mechanism and Acceleration Restraint Operator [#E-14360]*

Jiangshao Gu and Xuanhua Shi, Huazhong University of Science and Technology, China

To obtain precise solutions in optimization problems and decrease the risk of being trapped in local optima, researchers have studied on various improved particle swarm optimizations (PSO) and made a series of achievements. However, these methods focus on artificially altering the physical rules of motion, rather than strengthening the individual self-learning and adjustment during the optimization process, which is the original motive of the swarm-based evolutionary algorithms. In this paper, we propose a fresh self-adaptive variant, MMARO-PSO, which employs motivation mechanism to simulate the behavior of intelligent organisms more vividly. We manage to simplify the update formulas and give each term a definite bio-psychic sense. Furthermore, we introduce a vectorized operator to restrain particle's acceleration, instead of the inertia weight parameter in conventional methods. Large number of experiments were conducted and the results illustrate that these innovations make the technique perform more consistently to find a better balance between global exploration and local exploitation, compared with the existing versions, e.g. SPSO, e1-PSO, ARFPSO, and (k,l)PSO.

P503 *The Enhanced Vector of Convergence for Particle Swarm Optimization Based on Constrict Factor [#E-14366]*

Wei Zhang, Yanan Gao and Chengxing Zhang, University of Georgia, United States; Lanzhou University of Technology, China; Lanzhou University of Finance and Economic, China

The Particle Swarm Optimizer is used very widely for unimodal and multi-modal optimization problems. Recently, most of variant PSOs are combing several evolutionary strategies in order to achieve a better performance on Benchmark functions, and even for shifted, rotated, or composite functions. In this paper, a new method known as Enhanced Vector of Convergence is proposed and combined with constrict factor to improve the convergence performance of Particle Swarm Optimizer. In experimental study, other 5 variant Particle Swarm Optimizers are compared, and acceptance rate, t-Test are used for further evaluation. The results indicate that the Enhance Vector of Convergence can significantly improve the accurate level of Particle Swarm Optimizer.

P504 *Evolutionary Semi-Supervised Learning with Swarm Intelligence [#E-14426]*

Xiaohua Xu, Lin Lu, Ping He, Jie Ding and Yongsheng Ju, Yangzhou University, China

To address the issue of evolutionary data classification, we propose an evolving swarm classification model. It treats each class as an ant colony carrying different type of pheromone. The ant colonies send their members to propagate their unique pheromone on the unlabeled instances, so as to label them for member recruitment. Meanwhile, the unlabeled instances are treated as unlabeled ants, which also have their preferences for joining one of those labeled colonies. We call it homing feedback, and integrate it into the pheromone update process. Afterwards, the natural selection process is carried out to keep a balance between the member recruitment and the ant colony size maintenance. Sufficient experiments demonstrate that our algorithm is effective in the real-world evolutionary classification applications.

P505 *A Fast Restarting Particle Swarm Optimizer [#E-14430]*

Junqi Zhang, Xiong Zhu, Wei Wang and Jing Yao, Tongji University, China

Particle swarm optimization (PSO) is a swarm intelligence technique that optimizes a problem by iterative exploration and exploitation in the search space. However, PSO cannot achieve the preservation of population diversity on solving multi-model problems, and once the swarm falls into local convergence, it cannot jumps out of the local trap. In order to solve this problem, this paper presents a fast restarting particle swarm optimization (FRPSO), which uses a novel restarting strategy based on a discrete finite-time particle swarm optimization (DFPSO). Taking advantage of frequently speeding up the swarm to converge along with a greater exploitation capability and then jumping out of the trap, this algorithm can preserve population diversity and provide a superior solution. The experiment performs on twenty-five benchmark functions which consist of single-model, multi-model and hybrid composition problems, and the experimental result demonstrates that the performance of the proposed FRPSO algorithm is better than the other three representatives of the advanced PSO algorithm on most of these functions.

P506 *Dimensions Cooperate by Euclidean Metric in Particle Swarm Optimization [#E-14435]*

Zezhou Li, Junqi Zhang, Wei Wang and Jing Yao, Tongji University, China

Since Particle Swarm Optimization (PSO) was introduced, variants of PSO have usually updated velocities of particles in each dimension independently in the high-dimensional space. This paper proposes a Dimensionally Cooperative PSO (DCPSO), in which dimensions cooperate to update velocities of particles through Euclidean metric. The Euclidean metric first builds pbest-centered and gbest-centered hyperspheres. And then, velocity vectors of particles are derived from stochastic points obeying a distribution within the hyperspheres for dimensions cooperating. To the best knowledge of the authors, DCPSO is the first to investigate such cooperation of dimensions through Euclidean metric, instead of updating each dimension independently. Compared with the traditional PSO, DCPSO is validated by simulations on the 20 standard benchmark problems from CEC 2013. Furthermore, the differences between the behaviors of the traditional PSO and the proposed DCPSO are analyzed from the aspect of the search space. Meanwhile, the curse of dimensionality is illustrated by comparisons between the traditional PSO and DCPSO in distinct dimensions.

P507 *Biclustering of Gene Expression Data Using Particle Swarm Optimization Integrated with Pattern-Driven Local Search [#E-14235]*

Yangyang Li, Xiaolong Tian, Licheng Jiao and Xiangrong Zhang, Xidian University, China

Biclustering is of great significance in the analysis of gene expression data and is proven to be a NP-hard problem. Among the existing intelligent optimization algorithms used in the gene expression data analysis, most concentrate on the global search ability but ignore the inherent trajectory information of gene expression data, so the search efficiency is low. In this paper, a pattern-driven local search operator is incorporated in the binary Particle Swarm Optimization (PSO) algorithm in order to improve the search efficiency. Experiments show that our approach is valid.

P508 *Simulating the Coevolution of Language and Long-Term Memory [#E-14344]*

Lan Shuai, Zhen Wang and Tao Gong, Johns Hopkins University, United States; Dalian University of Technology, China; University of Hong Kong, Hong Kong

Memory is fundamental to social activities such as language communications, yet it remains unclear how memory capacity and language use influence each other during language evolution, especially the early stage of language origin. Here, we proposed an evolutionary framework to address this issue. It assumed a genetic transmission of memory capacity and integrated natural and cultural selections that respectively affected the choices of parents for reproducing offspring and teaching these offspring. Simulation results obtained under this framework and relevant statistical analyses collectively traced a coevolution of language and capacity of individual long-term memory for storing acquired linguistic knowledge during the origin of a communal language in a multi- individual population. In line with the coevolutionary theory of language and related cognitive competences, this simulation study demonstrated that culturally-constituted aspects (communicative success)

could drive the natural selection of predisposed cognitive features (long-term memory capacity), thus showing that language resulted from biological evolution, individual learning, and socio-cultural transmissions.

P509 *Evolutionary Clustering with Differential Evolution [#E-14553]*

Gang Chen, Wenjian Luo and Tao Zhu, University of Science and Technology of China, China

Evolutionary clustering is a hot research topic that clusters the time-stamped data and it is essential to some important applications such as data streams clustering and social network analysis. An evolutionary clustering should accurately reflect the current data at any time step while simultaneously not deviate too drastically from the recent past. In this paper, the differential evolution (DE) is applied to deal with the evolutionary clustering problem. Comparing with the typical k-means, evolutionary clustering based on DE (deEC) could perform a global search in the solution space. Experimental results over synthetic and real-world data sets demonstrate that the deEC provides robust and adaptive solutions.

P510 *Smart Hybrid Genetic Algorithms in the Bandwidth Optimization of a PIFA Antenna [#E-14369]*

Mohammad Riyad Ameerudden and Harry Rughooputh, University of Mauritius, Mauritius

With the exponential development of mobile communications and the miniaturization of radio frequency transceivers, the need for small and low profile antennas at mobile frequencies is constantly growing. Therefore, new antennas should be developed to provide both larger bandwidth and small dimensions. This paper presents a smart optimization technique using a hybridized Genetic Algorithms (GA) and comparison with more classical GA techniques. The hybridization involves primarily a clustering mechanism coupled with the intelligence of the Binary String Fitness Characterization (BSFC) technique. The optimization engine is applied to the design of a Planar Inverted-F Antenna (PIFA) in order to achieve an optimal bandwidth performance in the 2 GHz band. During the optimization process, the PIFA is modeled and evaluated using the finite-difference time domain (FDTD) method.

P511 *Evolutionary Many-Objective Optimization by MO-NSGA-II with Enhanced Mating Selection [#E-14381]*

Shao-Wen Chen and Tsung-Che Chiang, National Taiwan Normal University, Taiwan

Many-objective optimization deals with problems with more than three objectives. The rapid growth of non-dominated solutions with the increase of the number of objectives weakens the search ability of Pareto-dominance-based multiobjective evolutionary algorithms. MO-NSGA-II strengthens its dominance- based predecessor, NSGA-II, by guiding the search process with reference points. In this paper, we further improve MO-NSGA-II by enhancing its mating selection mechanism with a hierarchical selection and a neighborhood concept based on the reference points. Experimental results confirm that the proposed ideas lead to better solution quality.

P512 *A Niching Two-Layered Differential Evolution with Self-Adaptive Control Parameters [#E-14397]*

Yongxin Luo, Sheng Huang and Jinglu Hu, WASEDA University, Japan

Differential evolution (DE) is an effective and efficient evolutionary algorithm in continuous space. The setting of control parameters is highly relevant with the convergence efficiency, and varies with different optimization problems even at different stages of evolution. Self-adapting control parameters for finding global optima is a long-term target in evolutionary field. This paper proposes a two-layered DE (TLDE) with self- adaptive control parameters combined with niching method based mutation strategy. The TLDE consists of two DE layers: a bottom DE layer for the basic evolution procedure, and a top DE layer for control parameter adaptation. Both layers follow the procedure of DE. Moreover, to mitigate the common phenomenon of premature convergence in DE, a clearing niching method is brought out in finding efficient mutation individuals to maintain diversity during the evolution and stabilize the evolution system. The performance is validated by a comprehensive set of twenty benchmark functions in parameter optimization and competitive results are presented.

P513 *Application of the MOAA for the Optimization of CORAIL Assemblies for Nuclear Reactors [#E-14412]*

Valerio Lattarulo, Benjamin A. Lindley and Geoffrey T. Parks, University of Cambridge, Great Britain

The Multi-objective Alliance Algorithm (MOAA), a recently introduced optimization algorithm, is used for the optimization of heterogeneous low-enriched uranium (LEU) + mixed-oxide fuel (MOX) assemblies for pressurized water reactors (PWRs). This is a constrained nuclear problem with two objectives and a mixed-integer solution space. The efficacy of the algorithm is demonstrated through comparisons with NSGAII for between 300 and 2000 function evaluations. Through the epsilon and hypervolume indicators and the Kruskal-Wallis statistical test, we show that the MOAA outperforms NSGA-II on this problem. The MOAA was also able to find a set of solutions that are better than the 'expert solution' for this problem.

P514 *A Hybrid Approach Based on Genetic Algorithms for Solving the Clustered Vehicle Routing Problem [#E-14422]*

Petrica Pop and Camelia Chira, Technical University of Cluj-Napoca, Romania

In this paper, we describe a hybrid approach based on the use of genetic algorithms for solving the Clustered Vehicle Routing Problem, denoted by CluVRP. The problem studied in this work is a generalization of the classical Vehicle Routing Problem (VRP) and is closely related to the Generalized Vehicle Routing Problem (GVRP). Along with the genetic algorithm, we consider a local-global approach to the problem that is reducing considerably the size of the solutions space. The obtained computational results point out that our algorithm is an appropriate method to explore the search space of this complex problem and leads to good solutions in a reasonable amount of time.

P515 *Identifying and Exploiting the Scale of a Search Space in Differential Evolution [#E-14719]*

James Montgomery, Stephen Chen and Yasser Gonzalez-Fernandez, University of Tasmania, Australia; York University, Canada

Optimisation in multimodal landscapes involves two distinct tasks: identifying promising regions and location of the (local) optimum within each region. Progress towards the second task can interfere with the first by providing a misleading estimate of a region's value. Thresheld convergence is a generally applicable "meta"-heuristic designed to control an algorithm's rate of convergence and hence which mode of search it is using at a given time. Previous applications of thresheld convergence in differential evolution (DE) have shown considerable promise, but the question of which threshold values to use for a given (unknown) function landscape remains open. This work explores the use of clustering-based method to infer the distances between local optima in order to set a series of decreasing thresholds in a multi-start DE algorithm. Results indicate that on those problems where normal DE converges, the proposed strategy can lead to sizable improvements.

P516 *Enhancing Relevance Re-Ranking Using Nature-Inspired Meta-Heuristic Optimization Algorithms [#E-14730]*

Amel Ksibi, Anis Ben Ammar and Chokri Ben Amar, REGIM lab, Tunisia

Over the last years, Relevance re-ranking has been an attractive research, aiming to re-order the initial image search result list by which relevant results should be at the top ranking list and irrelevant results should be pruned. In this paper, we propose to explore two population-based meta-heuristic algorithms, which are Particle Swarm optimization(PSO), and Cuckoo search(CS), in order to solve the relevance re-ranking problem as a constrained regularisation framework. By doing so, we define two reranking processes, reffered as APSORank and CS-Rank that converge to the optimal ranked list. Results are further provided to demonstrate the effectiveness and performance of these two reranking processes.

P517 *Can Deterministic Chaos Improve Differential Evolution for the Linear Ordering Problem? [#E-14739]*

Pavel Kromer, Ivan Zelinka and Vaclav Snasel, VSB-TU Ostrava, Czech Republic

Linear ordering problem is a popular NP-hard combinatorial optimization problem attractive for its complexity, rich library of test data, and variety of real world applications. It has been solved by a number of heuristic as well as metaheuristic methods in the past. The implementation of nature-inspired metaheuristic optimization and search methods usually depends on streams of integer and floating point numbers generated in course of their execution. The pseudo-random numbers are utilized for an in-silico emulation of probability-driven natural processes such as arbitrary modification of genetic information (mutation, crossover), partner selection, and survival of the fittest (selection, migration) and environmental effects (small random changes in particle motion direction and velocity). Deterministic chaos is a well known mathematical concept that can be used to generate sequences of seemingly random real numbers within selected interval in a predictable and well controllable way. In the past, it has been used as a basis for various pseudo-random number generators with interesting properties. Recently, it has been shown that it can be successfully used as a source of stochasticity for nature-inspired algorithms solving a continuous optimization problem. In this work we compare effectiveness of the differential evolution with different pseudo-random number generators and chaotic systems as sources of stochasticity when solving the linear ordering problem.

P518 *Two Parameter Update Schemes for Recurrent Reinforcement Learning [#E-14245]*

Jin Zhang and Dietmar Maringer, University of Basel, Switzerland

Recurrent reinforcement learning (RRL) is a machine learning algorithm which has been proposed by researchers for constructing financial trading platforms. When an analysis of RRL trading performance is conducted using low frequency financial data (e.g. daily data), the weakening autocorrelation in price changes may lead to a decrease in trading profits as compared to its applications in high frequency trading. There therefore is a need to improve RRL for the purposes of daily equity trading. This paper presents two parameter update schemes (the `average elitist' and the `multiple elitist') for RRL. The purpose of the first scheme is to improve out-of-sample performance of RRL-type trading systems. The second scheme aims to exploit serial dependence in stock returns to improve trading performance, when traders deal with highly correlated stocks. Profitability and stability of the trading system are examined by using four groups of Standard and Poor stocks for the period January 2009 to December 2012. It is found that the Sharpe ratios of the stocks increase after we use the two parameter update schemes in the RRL trading system.

P519 *Differential Evolution Strategy Based on the Constraint of Fitness Values Classification [#E-14594]*

Zhihui Li, Zhigang Shang, Jane Jing Liang and Boyang Qu, Zhengzhou univerisity, China; Zhongyuan University of Technology, China

This paper presents a new Differential Evolution (DE) strategy, named as FCDE, based on the constraint of classification of fitness function values. To ensure the population could move to the better fitness landscape, the global fitness value distribution information of the objective function are used and all points in the population are classified into three class by their fitness values in each generation, so the points in each class choose their donor vector and differential vector from the points in adjacent senior class to form the trial vector. This strategy could speed up the convergence to global optimal as well as avoid falling into the local optimal. Another attractive character of FCDE is the control parameters in this DE variant are self-adaptive. This method is tested on the 30 benchmark functions of CEC2014 special session and competition on single objective real-parameter numerical optimization. The experimental results showed acceptable reliability of this strategy in high search dimension. This paper will participate in the competition on real parameter single objective optimization to compare with other algorithms.

P520 *A Lagrangian and Surrogate Information Enhanced Tabu Search for the MMKP [#E-14854]*

Skander Htiouech and Sadok Bouamama, National Engineering School of Tunis, Tunisia; National School of Computer Science of Tunisia, Tunisia

The multidimensional multi-choice knapsack problem (MMKP) is NP-hard. Within the framework of solving this problem, we suggest newer approaches. We not only propose a multi-starts version of our previous works aproach using surrogate constraint informations based choices, but also we introduce another newer heuristic. The latter uses Lagrangian relaxation informations in place of surrogate informations. Compared with other literature known methods described so far, our approaches experimentations results are competitive.

P521 *Estimation of Distribution Algorithms Based Unmanned Aerial Vehicle Path Planner Using a New Coordinate [#E-14405]*

Peng Yang, Ke Tang and Jose Antonio Lozano, University of Science and Technology of China, China; University of the Basque Country, Spain

Path planning technique is vital to Unmanned Aerial Vehicle (UAV). Evolutionary Algorithms (EAs) have been widely used in planning path for UAV. In these EA-based path planners, Cartesian coordinate system and polar coordinate system are commonly used to codify the path. However, either of them has its drawback: Cartesian coordinate systems result in an enormous search space, whilst polar coordinate systems are unfit for local modifications resulting e.g., from mutation and/ or crossover. In order to overcome these two drawbacks, we solve the UAV path planning in a new coordinate system. As the new coordinate system is only a rotation of Cartesian coordinate system, it is inherently easy for local modification. Besides, this new coordinate system has successfully reduced the search space by explicitly dividing the mission space into several subspaces. Within this new coordinate system, an Estimation of Distribution Algorithms (EDAs) based path planner is proposed in this paper. Some experiments have been designed to test different aspects of the new path planner. The results show the effectiveness of this planner.

P522 *An Uncultivated Wolf Pack Algorithm for High-Dimensional Functions and Its Application in Parameters Optimization of PID Controller [#E-14438]*

Husheng Wu, Fengming Zhang and Lushan Wu, Air Force Engineering University, China; Shanghai University of Engineering Science, China

To solve high-dimensional function optimization problems, many swarm intelligent algorithms have been proposed. Inspired by hunting behavior and distribution mode of uncultivated and barbarous wolf pack, we proposed a method, named uncultivated wolf pack algorithm (UWPA). Experiments are conducted on a suit of high-dimensional benchmark functions with different characteristics. What's more, the compared simulation experiments with other three typical intelligent algorithms, show that UWPA has better convergence and robustness. At last, this algorithm is successfully applied in parameters searching for PID controller.

P523 *On the Inference of Deterministic Chaos: Evolutionary Algorithm and Metabolic P System Approaches [#E-14440]*

Luca Marchetti, Vincenzo Manca and Ivan Zelinka, University of Verona, Italy; VSB Technical University of Ostrava, Czech Republic

This paper shows the possibility of using Metabolic P systems (MP systems) for chaotic system identification-reconstruction and it compares presented results with previous ones obtained by evolutionary algorithms. An important potentiality of MP theory is given by its powerful computational chaos generation that can be also used as an internal module of evolutionary algorithms by increasing their ability in specific cases of their application. Reported numerical experiments are discussed at the end.

P524 *A New Method and Application for Controlling the Steady-State Probability Distributions of Probabilistic Boolean Networks [#E-14444]*

Meng Yang, Rui Li and Tianguang Chu, Peking University, Beijing, China

Probabilistic Boolean networks (PBNs) have been proved to be a useful tool for modeling genetic regulatory interactions. The study of the steady-state probability distribution may help to understand the essential long-run behavior of a PBN. In this paper we focus on a type of PBNs derived from gene expression data collected in a study of metastatic melanoma. The metastatic melanoma model is usually described by a PBN containing seven genes among which WNT5A plays a significant role in the development of melanoma and is known to induce the metastasis of melanoma when highly active. This paper investigates the issue of how to drive the corresponding PBN towards desired steady-state probability distributions so as to reduce the WNT5A's ability to induce a metastatic phenotype.

P525 *Evolutionary Community Detection in Social Networks [#E-14706]*

Tiantian He and Keith C.C. Chan, The Hong Kong Polytechnic University, Hong Kong

As people that share common characteristics and interests tend to communicate with each other more frequently, they form communities within social networks. Several methods have been developed to discover such communities based on topological metrics. These methods have been used to successfully discover communities that are relatively large, but for communities characterized by members interacting more frequently with each other rather than interacting with many others, we propose here an effective method which is based on the use of an evolutionary algorithm (EA) called ECDA. Given a social network represented as a graph, unlike existing approaches, ECDA considers both topological metrics of the graph and the attributes of the vertices and edges when detecting for communities in the network. It performs its task by formulating the community detection problem as an optimization problem. By computing a measure of statistical significance for each attribute of the vertices, ECDA looks for communities in a network that have maximal connection significance within a community and minimal significance between any two communities. With such a strategy, ECDA partitions a network into different communities consisting of members with similar attributes within and different attributes without. Unlike other EAs, ECDA adopts a reproduction process consisting of special crossover and mutation operators, called Self-Evolution, to speed up the evolutionary process. ECDA has been tested with several real datasets and its performance is found to be very promising.

P526 *Experiments in Program Synthesis with Grammatical Evolution: A Focus on Integer Sorting [#E-14718]*

Michael O'Neill, Miguel Nicolau and Alexandros Agapitos, University College Dublin, Ireland

We present the results of a series of investigations where we apply a form of grammar-based genetic programming to the problem of program synthesis in an attempt to evolve an Integer Sorting algorithm. The results confirm earlier research in the field on the difficulty of the problem given a primitive set of functions and terminals. The inclusion of a swap(i,j) function in combination with a nested for loop in the grammar enabled a successful solution to be found in every run. We suggest some future research directions to overcome the challenge of evolving sorting algorithms from primitive functions and terminals.

P527 *A Social-Evolutionary Approach to Compose a Similarity Function Used on Event Recommendation [#E-14567]*

Luiz Mario Lustosa Pascoal, Celso Goncalves Camilo-Junior, Edjalma Queiroz Silva and Thierson Couto Rosa, Universidade Federal de Goias, Brazil

With the development of web 2.0, social networks have achieved great space on the internet, with that many users provide information and interests about themselves. There are expert systems that use the user's interests to recommend different products, these systems are known as Recommender Systems . One of the main techniques of a Recommender Systems is the Collaborative Filtering (User based) which recommends products to users based on what other similar people liked in the past. However, the methods to determine similarity between users have presented some problems. Therefore, this work presents a proposal of using social variables in the composition of the similarity function applied to a user on the recommendation of events. To test the proposal, details of friends and events of two target-users of the social network Facebook have been extracted. The results were compared with different deterministic heuristics, the Euclidean Distance and a aleatory method. The proposed model showed promising results and great potential to expand to different contexts.

P528 *Applying Evolutionary Computation for Evolving Ontologies [#E-14579]*

Oliviu Matei, Diana Contras and Petrica Pop, Technical University of Cluj-Napoca, North University Centre of Baia Mare, Romania; Technical University of Cluj-Napoca, Romania

In this paper, we describe a novel application of evolutionary computation, namely for evolving ontologies. The general algorithm of evolutionary ontologies follow roughly the same guidelines as any other genetic algorithms. However, we introduced a new genetic operator, called repair, which is needed in order to make the offspring viable. Experiments for the generation of user centered automatically generated scenes demonstrate the performance of the proposed approach.

Wednesday, July 9, 4:00PM-6:00PM

Special Session: WeE2-1 Evolutionary Computation in Dynamic and Uncertain Environments

Wednesday, July 9, 4:00PM-6:00PM, Room: 203A, Chair: Michalis Mavrovouniotis

4:00PM *Find Robust Solutions Over Time by Two-Layer Multi-Objective Optimization Method [#E-14046]*

Yinan Guo, Meirong Chen, Haobo Fu and Yun Liu, China University of Mining and Technology, China; University of Birmingham, United Kingdom

Robust optimization over time is a practical dynamic optimization method, which provides two detailed computable metrics to get the possible robust solutions for dynamic scalar optimization problems. However, the robust solutions fit for more time-varying moments or approximate the optimum more because only one metric is considered as the optimization objective. To find the true robust solution set satisfying maximum both survival time and average fitness simultaneously during all dynamic environments, a novel two-layer multi- objective optimization method is proposed. In the first layer, considering both metrics, the acceptable optimal solutions for each changing environment is found. Subsequently, they are composed of the practical robust solution set in the second layer. Taking the average fitness and the length of the robust solution set as two objectives, the optimal combinations for the whole time- varying environments are explored. The experimental results for the modified moving peaks benchmark shows that the robust solution sets considering both metrics are superior to the robust solutions gotten by ROOT. As the key parameters, the fitness threshold has the more obvious impact on the performances of MROOT than the time window, whereas ROOT is more sensitive to both of them.

4:20PM *Niching-Based Self-adaptive Ensemble DE with MMTS for Solving Dynamic Optimization Problems [#E-14634]*

Sheldon Hui and Ponnuthurai Nagaratnam Suganthan, Nanyang Technological University, Singapore

Dynamic and non-stationary problems require optimization algorithms search for the best solutions in a time-varying fitness environment. Various methods and strategies such as niching, clustering and sub-population approaches have been implemented with Differential Evolution (DE) to handle such problems. With the help of crowding niching to maintain general population diversity, this paper attempts to extend the Self-adaptive Ensemble DE with modified multi-trajectory search attempt to solve CEC2014 dynamic optimization competition benchmark problems.

4:40PM *Interactive and Non-Interactive Hybrid Immigrants Schemes for Ant Algorithms in Dynamic Environments [#E-14537]*

Michalis Mavrovouniotis and Shengxiang Yang, De Montfort University, United Kingdom

Dynamic optimization problems (DOPs) have been a major challenge for ant colony optimization (ACO) algorithms. The integration of ACO algorithms with immigrants schemes showed promising results on different DOPs. Each type of immigrants scheme aims to address a DOP with specific characteristics. For example, random and elitism-based immigrants perform well on severely and slightly changing environments, respectively. In this paper, two hybrid immigrants, i.e., non-interactive and interactive, schemes are proposed to combine the merits of the aforementioned immigrants schemes. The experiments on a series of dynamic travelling salesman problems showed that the hybridization of immigrants further improves the performance of ACO algorithms

5:00PM *What Are Dynamic Optimization Problems? [#E-14213]*

Haobo Fu, Peter Lewis, Bernhard Sendhoff, Ke Tang and Xin Yao, University of Birmingham, United Kingdom; Aston University, United Kingdom; Honda Research Institute Europe, Germany; University of Science and Technology of China, China

Dynamic Optimization Problems (DOPs) have been widely studied using Evolutionary Algorithms (EAs). Yet, a clear and rigorous definition of DOPs is lacking in the Evolutionary Dynamic Optimization (EDO) community. In this paper, we propose a unified definition of DOPs based on the idea of multiple-decision-making discussed in the Reinforcement Learning (RL) community. We draw a connection between EDO and RL by arguing that both of them are studying DOPs according to our definition of DOPs. We point out that existing EDO or RL research has been mainly focused on some types of DOPs. A conceptualized benchmark problem, which is aimed at the systematic study of various DOPs, is then developed. Some interesting experimental studies on the benchmark reveal that EDO and RL methods are specialized in certain types of DOPs and more importantly new algorithms for DOPs can be developed by combining the strength of both EDO and RL methods.

5:20PM *A Dynamic History-Driven Evolutionary Algorithm [#E-14351]*

Chi Kin Chow and Shiu Yin Yuen, City University of Hong Kong, Hong Kong

Dynamic objective problem (DOP) raises two challenging issues to evolutionary algorithm: comparing two individuals evaluated at different time instances and tracing the jumping global optimum. This paper presents a dynamic objective evolutionary algorithm (DOEA) that handles these issues through search history. The presented algorithm, namely dynamic objective history driven evolutionary algorithm(DyHdEA), stores the entire search history including the position, the fitness and the evaluated time of the solutions in a dynamic fitness tree. In the experiment section, DyHdEA is examined on a 10-dimensional DOP that is composed of five basis problems ranging from uni-modal to multi-modal, and from separable to non- separable. Meanwhile, the performance of DyHdEA is compared with five benchmark DOEAs including artificial immune algorithm, differential evolution, evolutionary programming, and particle swarm optimization. Seen from the result, DyHdEA effectively traces the dynamic global optimum with jumping transitions.

5:40PM *Adaptive Particle Swarm Optimization with Variable Relocation for Dynamic Optimization Problems [#E-14487]*

Zhi-Hui Zhan and Jun Zhang, Sun Yat-sen University, China

This paper proposes to solve the dynamic optimization problem (DOP) by using an adaptive particle swarm optimization (APSO) algorithm with an variable relocation strategy (VRS). The VRS based APSO algorithm (APSO/VRS) has the following two advantages when solving DOP. Firstly, by using the APSO optimizing framework, the algorithm benefits from the fast optimization speed due to the adaptive parameter control. More importantly, the adaptive parameter and operator in APSO make the algorithm fast response to the environment changes of DOP. Secondly, VRS was reported in the literature to help dynamic evolutionary algorithm (DEA) to relocate the individual position in promising region when environment changes. Therefore, the modified VRS used in APSO can collect historical information in the stability stage and use such information to guide the particle variable relocation in the change stage. We evaluated both APSO and APSO/VRS on several dynamic benchmark problems and compared with two state-of-the-art DEAs and DEA that also used the VRS. The results show that both APSO and APSO/VRS can obtain very competitive results on these problems, and APSO/VRS outperforms others on most of the test cases.

Special Session: WeE2-2 Intelligent Design for Reliable Cloud Computing

Wednesday, July 9, 4:00PM-6:00PM, Room: 203B, Chair: Wei-Chang Yeh

4:00PM *Macroscopic Indeterminacy Swarm Optimization (MISO) Algorithm for Real-Parameter Search [#E-14140]*

Po-Chun Chang and Xiangjian He, Advanced Analytics Institute University of Technology Sydney, Australia; University of Technology Sydney, Australia

Swarm Intelligence (SI) is a nature-inspired emergent artificial intelligence. They are often inspired by the phenomena in nature. Many proposed algorithms are focused on designing new update mechanisms with formulae and equations to emerge new solutions. Despite the techniques used in an algorithm being the key factor of the whole system, the evaluation of candidate solutions also plays an important role. In this paper, the pro-posed algorithm Macroscopic Indeterminacy Swarm Optimiza-tion (MISO) presents a new search scheme with indeterminate moment of evaluation. Here, we perform an experiment based on public benchmark functions. The results produced by MISO, Differential Evolution (DE) with various settings, Artificial Bee Colony (ABC), Simplified Swarm Optimization (SSO), and Parti-cle Swarm Optimization (PSO) have been compared. The result shows MISO can achieve similar or even better performance than other algorithms.

4:20PM *A Cooperative Honey Bee Mating Algorithm and Its Application in Multi-Threshold Image Segmentation [#E-14389]*

Yunzhi Jiang, Zhenlun Yang, Zhifeng Hao, Yinglong Wang and Huojiao He, Jiangxi Agricultural University, China; South China University of Technology, China

The problems of multi-threshold image segmentation remain great challenges for image compression, target recognition and computer vision. However, most of them are time-consuming. This paper proposes a cooperative honey bee mating-based algorithm (CHBMA) for image segmentation to save computation time while conquer the curse of dimensionality. CHBMA, based on honey bee mating algorithms (HBMA) and the cooperative learning, greatly enhances the search capability of the algorithm. Moreover, we adopt a new population initialization strategy to make the search more efficient, according to the characters of multilevel thresholding in an image arranged from a low gray level to a high one. Extensive experiments have shown that CHBMA can deliver more effective and efficient results to be applied in complex image processing such as automatic target recognition, compared with state-of-the-art population-based thresholding methods.

4:40PM *A RFID Network Design Methodology for Decision Problem in Health Care [#E-14481]*

Chun-Hua Chou, Huang Chia-Ling and Po-Chun Chang, National TsingHua University, Taiwan; Kainan University, Taiwan; University of Technology Sydney, Austria

This research extends our previous work on decision makers with methodology to optimize the design of a strategy for constructing Radio Frequency Identification (RFID). RFID technology is an automatic identification system through radio frequency for transferring data. Before deploying RFID system, one of the challenging problems is RFID network planning (RNP). The RNP problem must be solved to operate the large-scale network of readers, and need to satisfy a set of requires, such as coverage rate, economic, interference. This paper extends our previous work using soft computing technique to find the optimal positions of RFID readers based on Simplified Swarm Optimization (SSO) algorithm. Meanwhile, the fuzzy-ART and K-means models are applied to efficiently and effectively search better solutions

5:00PM *Pareto Simplified Swarm Optimization for Grid-Computing Reliability and Service Makspan in Grid-RMS [#E-14841]*

Wei Shang-Chia, Yeh Wei-Chang and Yen Tso-Jung, Institute of Statistical Science, Academia Sinica, Taiwan; National TsingHua University, Taiwan

In a grid-computing service, Grid-RMS must generate suitable assignment combinations (execution blocks) for dependable service quality and satisfactory makespan (service time). In this paper, service reliability of a grid environment and makespan of a grid application are estimated via the universal generating function methodology and probability theory. Then, we represent a simplified swarm optimization (SSO) with the Pareto-set cluster (PC) to search the best assignment combinations in a grid environment with star topology. In terms of the task partition and distribution for a grid application, we employ a Pareto-set cluster to guide particle evolution, an elitist strategy to promote solution quality, and a simplified update mechanism to enhance the multi-objective optimization effectiveness. Finally, we assess the performance of the PC-SSO by the interactive tradeoff problem based on the analysis of four scenarios with respect to the bi-objective problem and given restrictions.

5:20PM *A New Grouping Genetic Algorithm for the MapReduce Placement Problem in Cloud Computing [#E-14305]*

Xiaoyong Xu and Maolin Tang, Queensland University of Technology, Australia

MapReduce is a computation model for processing large data sets in parallel on large clusters of machines, in a reliable, fault-tolerant manner. A MapReduce computation is broken down into a number of map tasks and reduce tasks, which are performed by so called mappers and reducers, respectively. The placement of the mappers and reducers on the machines directly affects the performance and cost of the MapReduce computation. From the computational point of view, the mappers/reducers placement problem is a generation of the classical bin packing problem, which is NP-complete. Thus, in this paper we propose a new grouping genetic algorithm for the mappers/reducers placement problem in cloud computing. Compared with the original one, our grouping genetic algorithm uses an innovative coding scheme and also eliminates the inversion operator which is an essential operator in the original grouping genetic algorithm. The new grouping genetic algorithm is evaluated by experiments and the experimental results show that it is much more efficient than four popular algorithms for the problem, including the original grouping genetic algorithm.

5:40PM *Composite SaaS Scaling in Cloud Computing Using a Hybrid Genetic Algorithm [#E-14780]*

Zeratul Mohd Yusoh and Maolin Tang, Universiti Teknikal Malaysia Melaka, Malaysia; Queensland University of Technology, Australia

A Software-as-a-Service or SaaS can be delivered in a composite form, consisting of a set of application and data components that work together to deliver higher-level functional software. Components in a composite SaaS may need to be scaled - replicated or deleted, to accommodate the user's load. It may not be necessary to replicate all components of the SaaS, as some components can be shared by other instances. On the other hand, when the load is low, some of the instances may need to be deleted to avoid resource underutilisation. Thus, it is important to determine which components are to be scaled such that the performance of the SaaS is still maintained. Extensive research on the SaaS resource management in Cloud has not yet addressed the challenges of scaling process for composite SaaS. Therefore, a hybrid genetic algorithm is proposed in which it utilises the problem's knowledge and explores the best combination of scaling plan for

the components. Experimental results demonstrate that the proposed algorithm outperforms existing heuristic-based solutions.

Special Session: WeE2-3 Single Objective Numerical Optimization II

Wednesday, July 9, 4:00PM-6:00PM, Room: 203C, Chair: Jane Jing Liang and Boyang Qu

4:00PM *A Differential Evolution with Replacement Strategy for Real-Parameter Numerical Optimization [#E-14520]*

Changjian Xu, Han Huang and ShuJin Ye, South China University of Technology, China

Differential Evolution (DE) has been widely used as a continuous optimization technique for several issues like electromagnetic optimization, bioprocess system optimization and so on. However, during the optimization process, DE's population may stagnate local optimums and it may waste a large number of function evaluations for the population to get rid of them. This paper presents an improved DE algorithm (denoted as RSDE) which combines a Replacement Strategy (RS). The motivation of RS is that replacing an unimproved individual and replacing a premature population using RS can enhance the DE exploitation performance and exploration performance respectively. We tested the RSDE performance using the newly Single Objective Real-Parameter Numerical Optimization problems provided by the CEC 2014 Special Session and Competition. Moreover, computational results and convergence figures are given for better compassion with other optimization algorithm during the conference and afterwards.

4:20PM *Evaluating the Mean-Variance Mapping Optimization on the IEEE-CEC 2014 Test Suite [#E-14612]*

Istvan Erlich, Jose L. Rueda and Sebastian Wildenhues, University Duisburg-Essen, Germany

This paper provides a survey on the performance of the hybrid variant of the Mean-Variance Mapping Optimization (MVMO-SH) when applied for solving the IEEE-CEC 2014 competition test suite on Single Objective Real-Parameter Numerical Optimization. MVMO-SH adopts a swarm intelligence scheme, where each particle is characterized by its own solution archive and mapping function. Besides, multi-parent crossover is incorporated into the offspring creation stage in order to force the particles with worst fitness to explore other sub-regions of the search space. In addition, MVMO-SH can be customized to perform with an embedded local search strategy. Experimental results demonstrate the search ability of MVMO-SH for effectively tackling a variety of problems with different dimensions and mathematical properties

4:40PM *Influence of Regions on the Memetic Algorithm for the Special Session on Real-Parameter Single Objetive Optimisation [#E-14649]*

Daniel Molina, Benjamin Lacroix and Francisco Herrera, University of Cadiz, Spain; University of Granada, Spain

Memetic algorithms with an appropriate trade-off between the exploration and exploitation can obtain very good results in continuous optimisation. That implies the evolutionary algorithm component should be focused in exploring the search space while the local search method exploits the achieved solutions. In a previous work, it was proposed a region-based algorithm, RMA-LSCh-CMA, adding to algorithm MA-LSCh-CMA a niching strategy that divides the domain search in equal hypercubes. The experimental results obtained, with the benchmark proposed in the CEC'2014 Special Session on Real-Parameter Single Objective Optimisation, show that the use of these regions allow the algorithm to obtain better results, specially in higher dimensions, and the resulting algorithm is more scalable.

5:00PM *Analysis and Classification of Optimisation Benchmark Functions and Benchmark Suites [#E-14044]*

Robert Garden and Andries Engelbrecht, University of Pretoria, South Africa

New and existing optimisation algorithms are often compared by evaluating their performance on a benchmark suite. This set of functions aims to evaluate the algorithm across a range of problems and serves as a baseline measurement of how the algorithm may perform on real-world problems. It is important that the functions serve as a good representative of commonly occurring problems. In order to select functions that will make up the benchmark suite, the characteristics and relationships among the functions must be known. This paper characterises the landscapes of two commonly used benchmark suites, and uses these landscape characteristics to obtain a high level view of the current state of benchmark functions. This is done by using a self-organising feature map to cluster and analyse functions based on landscape characteristics. It is found that while there are numerous functions that cover a wide range of characteristics, there are characteristics that are under represented, or not even covered at all. Furthermore, it is discovered that common benchmark suites are composed of functions which are highly similar according to the measured characteristics.

5:20PM *Testing United Multi-Operator Evolutionary Algorithms on the CEC2014 Real-Parameter Numerical Optimization [#E-14196]*

Saber Elsayed, Ruhul Sarker, Daryl Essam and Noha Hamza, University of New South Wales, Australia

This paper puts forward a proposal for combining multi-operator evolutionary algorithms (EAs), in which three EAs, each with multiple search operators, are used. During the evolution process, the algorithm gradually emphasizes on the best performing multi-operator EA, as well as the search operator. The proposed algorithm is tested on the CEC2014 single objective real-parameter competition. The results show that the proposed algorithm has the ability to reach good solutions

5:40PM *Improving the Search Performance of SHADE Using Linear Population Size Reduction [#E-14348]*

Ryoji Tanabe and Alex Fukunaga, The University of Tokyo, Japan

SHADE is an adaptive DE which incorporates success-history based parameter adaptation and one of the state-of-the-art DE algorithms. This paper proposes L-SHADE, which further extends SHADE with Linear Population Size Reduction (LPSR), which continually decreases the population size according to a linear function. We evaluated the performance of L-SHADE on CEC2014 benchmarks and compared its search performance with state-of-the-art DE algorithms, as well as the state-of-the-art restart CMA-ES variants. The experimental results show that L-SHADE is quite competitive with state-of-the-art evolutionary algorithms.

WeE2-4 Learning Classifier Systems

Wednesday, July 9, 4:00PM-6:00PM, Room: 203D, Chair: Hisao Ishibuchi

4:00PM *Towards Better Generalization in Pittsburgh Learning Classifier Systems [#E-14361]*

Shubhra Kanti Karmaker Santu, Md. Mustafizur Rahman, Md. Monirul Islam and Kazuyuki Murase, Bangladesh University of Engineering and Technology, Bangladesh; Univeristy of Fukui, Japan

Generalization ability of a classifier is an important issue for any classification task. This paper proposes a new evolutionary system, i.e., EDARIC, based on the Pittsburgh approach for evolutionary machine learning and classification. The new system uses a destructive approach that starts with large-sized rules and gradually decreases the sizes as evolution progresses. Unlike most previous works, EDARIC adopts an intelligent deletion mechanism, evolves a separate population for each class of a given problem and uses an ensemble system to classify unknown instances. These features help in avoiding over-fitting and class-imbalance problems, which are beneficial for improving generalization ability of a classification system. EDARIC also applies a rule post-processing step to exempt the evolution phase from the burden of tuning a large number of parameters. Experimental results on various benchmark classification problems reveal that EDARIC has better generalization ability in case of both standard and imbalanced data-sets compared to many existing algorithms in the literature.

4:20PM *GP-Based Kernel Evolution for L2-Regularization Networks [#E-14362]*

Simone Scardapane, Danilo Comminiello, Michele Scarpiniti and Aurelio Uncini, Sapienza University of Rome, Italy

In kernel-based learning methods, a crucial design parameter is given by the choice of the kernel function to be used. Although there is, in theory, an infinite range of potential candidates, a handful of kernels covers the majority of actual applications. Partly, this is due to the difficulty of choosing an optimal kernel function in absence of a-priori information. In this respect, Genetic Programming (GP) techniques have shown interesting capabilities of learning non-trivial kernel functions that outperform commonly used ones. However, experiments have been restricted to the use of Support Vector Machines (SVMs), and have not addressed some problems that are specific to GP implementations, such as diversity maintenance. In these respects, the aim of this paper is twofold. First, we present a customized GP-based kernel search method that we apply using an L2-Regularization Network as the base learning algorithm. Second, we investigate the problem of diversity maintenance in the context of kernel evolution, and test an adaptive criterion for maintaining it in our algorithm. For the former point, experiments show a gain in accuracy for our method against fine-tuned standard kernels. For the latter, we show that diversity is decreasing critically fast during the GP iterations, but this decrease does not seems to affect performance of the algorithm.

4:40PM *Generalized Classifier System: Evolving Classifiers with Cyclic Conditions [#E-14494]*

Xianneng Li, Wen He and Kotaro Hirasawa, Waseda University, Japan

Accuracy-based XCS classifier system has been shown to evolve classifiers with accurate and maximally general characteristics. XCS generally represents its classifiers with binary conditions encoded in a ternary alphabet, i.e., {0,1,hashtag}, where hashtag is a ``don't care" symbol, which can match with 0 and 1 in inputs. This provides one of the foundations to make XCS evolve an optimal population of classifiers, where each classifier has the possibility to cover a set of perceptions. However, when performing XCS to solve the multi-step problems, i.e., maze control problems, the classifiers only allow the agent to perceive its surrounding environments without the direction information, which are contrary to our human perception. This paper develops an extension of XCS by introducing cyclic conditions to represent the classifiers. The proposed system, named generalized XCS classifier system (GXCS), is dedicated to modify the forms of the classifiers from \emph{chains} to \emph{cycles}, which allows them to match with more adjacent environments perceived by the agent from different directions. Accordingly, a more compact population of classifiers can be evolved to perform the generalization feature of GXCS. As a first step of this research, GXCS has been tested on the benchmark maze control problems in which the agent can perceive its 8 surrounding cells. It is confirmed that GXCS can evolve the classifiers with cyclic conditions to successfully solve the problems as XCS, but with much smaller population size.

5:00PM *Applying LCS to Affective Images Classification in Spatial-Frequency Domain [#E-14794]*

Po-Ming Lee and Tzu-Chien Hsiao, National Chiao Tung University, Taiwan

Affective image classification is a task aims on classifying images based on their affective characteristics of inducing human emotions. This study accomplishes the task by using Linear Classifier System (LCS) and spatial-frequency features. The model built by using LCS achieves Area Under Curve (AUC) = 0.91 and accuracy rate over 86%. For comparison purposes, the result of the LCS is compared with other traditional machine learning classifiers (e.g., RBF Network) that are normally used in classification tasks. The study also presents user-independent results that indicate that the horizontal visual stimulations contribute more to emotion elicitation, than vertical visual stimulation.

5:20PM *A Novel Genetic Algorithm Approach for Simultaneous Feature and Classifier Selection in Multi Classifier System [#E-14343]*

Tien Thanh Nguyen, Alan Wee-Chung Liew, Minh Toan Tran, Xuan Cuong Pham and Mai Phuong Nguyen, Griffith University, Australia; Hanoi University of Science and Technology, Viet Nam; Massey University, New Zealand

In this paper we introduce a novel approach for classifier and feature selection in a multi-classifier system using Genetic Algorithm (GA). Specifically, we propose a 2-part structure for each chromosome in which the first part is encoding for classifier and the second part is encoding for feature. Our structure is simple in the implementation of the crossover as well as the mutation stage of GA. We also study 8 different fitness functions for our GA based algorithm to explore the optimal fitness functions for our model. Experiments are conducted on both 14 UCI Machine Learning Repository and CLEF2009 medical image database to demonstrate the benefit of our model on reducing classification error rate.

5:40PM *Lookup Table Partial Reconfiguration for an Evolvable Hardware Classifier System [#E-14586]*

Kyrre Glette and Paul Kaufmann, University of Oslo, Norway; University of Paderborn, Germany

The evolvable hardware (EHW) paradigm relies on continuous run-time reconfiguration of hardware. When applied on modern FPGAs, the technically challenging reconfiguration process becomes an issue and can be approached at multiple levels. In related work, virtual reconfigurable circuits (VRC), partial reconfiguration, and lookup table (LUT) reconfiguration approaches have been investigated. In this paper, we show how fine-grained partial reconfiguration of 6-input LUTs of modern Xilinx FPGAs can lead to significantly more efficient resource utilization in an EHW application. Neither manual placement nor any proprietary bitstream manipulation is required in the simplest form of the employed method. We specify the goal architecture in VHDL and read out the locations of the automatically placed LUTs for use in an online reconfiguration setting. This allows for an easy and flexible architecture specification, as well as possible implementation improvements over a hand-placed design. For demonstration, we rely on a hardware signal classifier application. Our results show that the proposed approach can fit a classification circuit 4 times larger than an equivalent VRC-based approach, and 6 times larger than a shift register- based approach, in a Xilinx Virtex-5 device. To verify the reconfiguration process, a MicroBlaze-based embedded system is implemented, and reconfiguration is carried out via the Xilinx Internal Configuration Access Port (ICAP) and driver software.

Special Session: WeC2-1 CIS and WCCI Competition Session
Wednesday, July 9, 4:00PM-6:00PM, Room: 311A, Chair: Swagatam Das and Alessandro Sperduti

4:00PM *IEEE CIS Ghosts Challenge 2013*
Alessandro Sperduti, University of Padova, Italy

The challenge consists in developing an autonomous agent able to successfully play Geister (a game with partially observable information). Alessandro Sperduti will talk about this competition's progress and results.

4:45PM *Evolutionary Computation for Dynamic Optimization Problems*
Changhe Li, Michalis Mavrovouniotis, Shengxiang Yang and Xin Yao, China University of Geosciences, China; De Montfort University, United Kingdom; University of Birmingham, United Kingdom

This competition aims at evaluating the current state of the art in single objective optimization with bound constraints and to propose novel benchmark problems with diverse characteristics. The algorithms will be evaluated with very small number of function evaluations to large number of function evaluations.

5:10PM *Optimization of Problems with Multiple Interdependent Components*
Sergey Polyakovskiy, Markus Wagner, Mohammad Reza Bonyadi, Frank Neumann and Zbigniew Michalewicz, The University of Adelaide, Australia

The competition provides a platform for comparing computational intelligence approaches to solve multi-component optimization problems. The organizers mainly focus on the combination of the TSP and the Knapsack problems in this context. In particular, Euclidian 2D Travelling Salesperson instances are combined with 0-1- Knapsack instances in such a way that it reflects characteristics of the real- world problems; for example, the total weight of the items in the knapsack influences the travel speed of a traveler.

5:35PM *First Neural Connectomics Challenge: From Imaging to Connectivity*
Demian Battaglia, Max Planck Institute for Dynamics and Self-Organization, Germany

This competition aims at advancing the research on network structure reconstruction algorithms from neurophysiological data, including causal discovery methods. The challenge will make use of realistic simulations of real networks of neurons observed via calcium fluorescence recordings. The participants are expected to come up with efficient algorithms for analyzing time series and large data-sets. List of organizers: Isabelle Guyon, Olav Stetter, Demian Battaglia, Javier Orlandi, Jordi Soriano Fradera, Mehreen Saeed, Alexander Statnikov, Bisakha Ray, Alice Guyon, Gavin Cawley, Gideon Dror, Hugo-Jair Escalante, Vincent Lemaire, Sisi Ma, Florin Popescu, and Joshua Vogelstein.

Thursday, July 10, 1:30PM-3:30PM

ThE1-1 Ant Colony Optimization
Thursday, July 10, 1:30PM-3:30PM, Room: 203A, Chair: Andries Engelbrecht

1:30PM *Ant Colony Optimization and Hypergraph Covering Problems [#E-14158]*
Ankit Pat, University of Waterloo, Canada

Ant Colony Optimization (ACO) is a very popular metaheuristic for solving computationally hard combinatorial optimization problems. Runtime analysis of ACO with respect to various pseudo-boolean functions and different graph based combinatorial optimization problems has been taken up in recent years. In this paper, we investigate the runtime behavior of an MMAS*(Max-Min Ant System) ACO algorithm on some well known hypergraph covering problems that are NP-Hard. In particular, we have addressed the Minimum Edge Cover problem, the Minimum Vertex Cover problem and the Maximum Weak-Independent Set problem. The influence of pheromone values and heuristic information on the running time is analysed. The results indicate that the heuristic information has greater impact towards improving the expected optimization time as compared to pheromone values. For certain instances of hypergraphs, we show that the MMAS* algorithm gives a constant order expected optimization time when the dominance of heuristic information is suitably increased.

1:50PM *Confidence-Based Ant Random Walks [#E-14775]*
Ping He, Ling Lu, Xiaohua Xu, Kanwen Li, Heng Qian and Wei Zhang, Yangzhou University, China

To facilitate the computer-aided medical applications, this paper tries to build better intelligent diagnosis systems with the help of swarm intelligence method. As to the clinical data, a built-in graph structure is constructed with training samples being mapped as labeled vertices and test samples being unlabeled vertices. On the basis of the iterative label propagation algorithm, this paper first introduces a confidence- based random walk learning model, where unlabeled vertices that consistently show high probability (above the confidence threshold) in belonging to one class is treated as labeled vertices in the next iteration. Later motivated by the swarm intelligence, this model is further improved by treating the labeled vertices as real ants in nature and the predefined classes as different ant colonies. A novel labeled ant random walk algorithm is introduced by incorporating the history information of random walk in the form of aggregation pheromone. The proposed algorithms are evaluated with a synthetic data as well as some real-life clinical cases in terms of diagnostic accuracy. Experimental results show the potentiality of the proposed algorithms.

2:10PM *The Coupled EigenAnt Algorithm for Shortest Path Problems [#E-14850]*
Eugenius Kaszkurewicz, Amit Bhaya, Jayadeva Jayadeva and Joao Marcos Meirelles da Silva, Federal University of Rio de Janeiro, Brazil; Indian Institute of Technology, India; Federal Fluminense University, Brazil

This paper introduces an ACO model and associated algorithm, called Coupled EigenAnt, for the problem of finding the shortest of N paths between a source and a destination node. It is based on the recently introduced EigenAnt algorithm, the novelty being that it allows probabilistic path choice on both the forward and return journeys, as well as the fact that it introduces decay of pheromone deposition following a geometric progression.

Equilibrium points of the model are calculated and the local stability of the two path synchronous version analyzed. Simulations illustrate the main features of the algorithm.

2:30PM *Accelerating Ant Colony Optimization-Based Edge Detection on the GPU Using CUDA [#E-14838]*

Laurence Dawson and Iain Stewart, Durham University, United Kingdom

Ant Colony Optimization (ACO) is a nature-inspired metaheuristic that can be applied to a wide range of optimization problems. In this paper we present the first parallel implementation of an ACO-based (image processing) edge detection algorithm on the Graphics Processing Unit (GPU) using NVIDIA CUDA. We extend recent work so that we are able to implement a novel data-parallel approach that maps individual ants to thread warps. By exploiting the massively parallel nature of the GPU, we are able to execute significantly more ants per ACO-iteration allowing us to reduce the total number of iterations required to create an edge map. We hope that reducing the execution time of an ACO-based implementation of edge detection will increase its viability in image processing and computer vision.

2:50PM *Absorption in Model-Based Search Algorithms for Combinatorial Optimization [#E-14193]*

Zijun Wu and Michael Kolonko, Technical University of Clausthal, Germany

Model-based search is an abstract framework that unifies the main features of a large class of heuristic procedures for combinatorial optimization, it includes ant algorithms, cross entropy and estimation of distribution algorithms. Properties shown for the model-based search therefore apply to all these algorithms. A crucial parameter for the long term behavior of model-based search is the learning rate that controls the update of the model when new information from samples is available. Often this rate is kept constant over time. We show that in this case after finitely many iterations, all model-based search algorithms will be absorbed into a state where all samples consist of a single solution only. Moreover, it cannot be guaranteed that this solution is optimal, at least not when the optimal solution is unique.

3:10PM *Elitism-Based Immigrants for Ant Colony Optimization in Dynamic Environments: Adapting the Replacement Rate [#E-14538]*

Michalis Mavrovouniotis and Shengxiang Yang, De Montfort University, United Kingdom

The integration of immigrants schemes with ant colony optimization (ACO) algorithms showed promising results on different dynamic optimization problems (DOPs). The principle of integrating immigrants schemes within ACO is to introduce newly generated ants that will replace other ants in the current population. One of the most advanced immigrants schemes is the elitism-based immigrants scheme, where the best ant from the previous environment is used as the base to generate immigrants. So far, the replacement rate used for elitism-based immigrants in ACO remained fixed during the execution of the algorithm. In this paper the impact of the replacement rate on the performance of ACO algorithms with elitism-based immigrants is examined. In addition, an adaptive replacement rate is proposed and compared with fixed and optimized replacement rates based on a series of DOPs. The experiments show that the adaptive scheme provides an automatic way to set a good value, although not the optimal one, for the replacement rate within ACO with elitism-based immigrants for DOPs

ThE1-2 Opposition-Based Learning and Differential Evolution

Thursday, July 10, 1:30PM-3:30PM, Room: 203B, Chair: Shahryar Rahnamayan

1:30PM *Gaussian Adaptation Based Parameter Adaptation for Differential Evolution [#E-14760]*

Rammohan Mallipeddi, Guohua Wu, Minho Lee and Ponnuthurai Nagaratnam Suganthan, Kyungpook National University, Korea (South); National University of Defense Technology, China; Nanyang Technological University, Singapore

Differential Evolution (DE), a global optimization algorithm based on the concepts of Darwinian evolution, is popular for its simplicity and effectiveness in solving numerous real-world optimization problems in real- valued spaces. The effectiveness of DE is due to the differential mutation operator that allows DE to automatically adjust between the exploration/exploitation in its search moves. However, the performance of DE is dependent on the setting of control parameters such as the mutation factor and the crossover probability. Therefore, to obtain optimal performance preliminary tuning of the numerical parameters, which is quite timing consuming, is needed. Recently, different parameter adaptation techniques, which can automatically update the control parameters to appropriate values to suit the characteristics of optimization problems, have been proposed. However, most of the adaptation techniques try to adapt each of the parameter individually but do not take into account interaction between the parameters that are being adapted. In this paper, we introduce a DE self-adaptive scheme that takes into account the parameters dependencies by means of a multivariate probabilistic technique based on Gaussian Adaptation working on the parameter space. The performance of the DE algorithm with the proposed parameter adaptation scheme is evaluated on the benchmark problems designed for CEC 2014.

1:50PM *Toward Using Type-II Opposition in Optimization [#E-14231]*

Hojjat Salehinejad, Shahryar Rahnamayan and Hamid R. Tizhoosh, University of Ontario, Canada; University of Waterloo, Canada

The concept of opposition-based learning (OBL) can be categorized into Type-I and Type-II OBL methodologies. The Type-I OBL is based on the opposite points in the variable space while the Type-II OBL considers the opposite of function value on the landscape. In the past few years, many research works have been conducted on development of Type-I OBL-based approaches with application in science and engineering, such as opposition-based differential evolution (ODE). However, compared to Type-I OBL, which cannot address a real sense of opposition in term of objective value, the Type-II OBL is capable to discover more meaningful knowledge about problem's landscape. Due to natural difficulty of proposing a Type-II-based approach, very limited research has been reported in that direction. In this paper, for the first time, the concept of Type-II OBL has been investigated in detail in optimization; also it is applied on the DE algorithm as a case study. The proposed algorithm is called oppositionbased differential evolution Type-II (ODE-II) algorithm; it is validated on the testbed proposed for the IEEE Congress on Evolutionary Computation 2013 (IEEE CEC-2013) contest with 28 benchmark functions. Simulation results on the benchmark functions demonstrate the effectiveness of the proposed method as the first step for further developments in Type-II OBL-based schemes.

2:10PM *Improved Differential Evolution with Adaptive Opposition Strategy [#E-14174]*

Huichao Liu, Zhijian Wu, Hui Wang, Shahryar Rahnamayan and Changshou Deng, Wuhan University, China; Nanchang Institute of Technology, China; University of Ontario Institute of Technology, Canada; Jiujiang University, China

Generalized opposition-based differential evolution (GODE) is an effective algorithm for global optimization over continuous search space. However, the performance of GODE highly depends on its control parameters. To improve the performance of GODE, this paper proposes an enhanced GODE algorithm called AGODE, which employs an adaptive generalized opposition-based learning (GOBL) mechanism to automatically adjust the probability of opposition during the evolution. Experimental study is conducted on a set of 19 wellknown benchmark functions. Computational results show that the proposed approach AGODE outperforms some state-of-theart DE variants on the majority of test problems.

2:30PM *Differential Evolution Assisted by a Surrogate Model for Bilevel Programming Problems [#E-14638]*

Jaqueline Angelo, Eduardo Krempser and Helio Barbosa, Laboratorio Nacional de Computacao Cientifica, Brazil

Bilevel programming is used to model decentralized problems involving two levels of decision makers that are hierarchically related. Those problems, which arise in many practical applications, are recognized to be challenging. This paper reports a Differential Evolution (DE) method assisted by a surrogate model to solve bilevel programming problems(BLPs). The method proposed is an extension of a previous one, BIDE, developed by the authors, where two DE methods are used to generate and evolve the upper and the lower level variables. Here, the use of a similarity-based surrogate model and a different stopping criteria are proposed in order to reduce the number of function evaluations on both levels of the bilevel optimization. The numerical results show a significant reduction in the number of function evaluations in the lower level of the problem.

2:50PM *Adaptive Inflationary Differential Evolution [#E-14736]*

Edmondo Minisci and Massimiliano Vasile, University of Strathclyde, United Kingdom

In this paper, an adaptive version of Inflationary Differential Evolution is presented and tested on a set of real case problems taken from the CEC2011 competition on real-world applications. Inflationary Differential Evolution extends standard Differential Evolution with both local and global restart procedures. The proposed adaptive algorithm utilizes a probabilistic kernel based approach to automatically adapt the values of both the crossover and step parameters. In addition the paper presents a sensitivity analysis on the values of the parameters controlling the local restart mechanism and their impact on the solution of one of the hardest problems in the CEC2011 test set.

3:10PM *Computing Opposition by Involving Entire Population [#E-14244]*

Shahryar Rahnamayan, Jude Jesuthasan, Farid Bourennani, Hojjat Salehinejad and Greg F. Naterer, University of Ontario Institute of Technology, Canada; University of Waterloo, Canada; Memorial University of Newfoundland, Canada

The capabilities of evolutionary algorithms (EAs) in solving nonlinear and non-convex optimization problems are significant. Among the many types of methods, differential evolution (DE) is an effective population-based stochastic algorithm, which has emerged as very competitive. Since its inception in 1995, many variants of DE to improve the performance of its predecessor have been introduced. In this context, opposition-based differential evolution (ODE) established a novel concept in which, each individual must compete with its opposite in terms of the fitness value in order to make an entry in the next generation. The generation of opposite points is based on the population's current extreme points (i.e., maximum and minimum) in the search space; these extreme points are not proper representatives for whole population, compared to centroid point which is inclusive regarding all individuals in the population. This paper develops a new scheme that utilizes the centroid point of a population to calculate opposite individuals. Therefore, the classical scheme of an opposite point is modified accordingly. Incorporating this new scheme into ODE leads to an enhanced ODE that is identified as centroid opposition-based differential evolution (CODE). The performance of the CODE algorithm is comprehensively evaluated on well-known complex benchmark functions and compared with the performance of conventional DE, ODE, and some other state-of-the-art algorithms (such as SaDE, ADE, SDE, and jDE) in terms of solution accuracy. The results for CODE are promising.

ThE1-3 Genetic Programming

Thursday, July 10, 1:30PM-3:30PM, Room: 203C, Chair: Michael O'Neill

1:30PM *Adaptive Genetic Network Programming [#E-14152]*

Xianneng Li, Wen He and Kotaro Hirasawa, Waseda University, Japan

Genetic Network Programming (GNP) is derived from Genetic Algorithm (GA) and Genetic Programming (GP), which applies evolution theory to evolve a population of directed graph to model complex systems. It has been shown that GNP can solve typical control problems, as well as many real-world problems. However, studying GNP is mainly focused on the specific aspect, while the fundamental characteristics that ensure the success of GNP are rarely investigated in the previous research. This paper reveals an important feature of GNP -- reusability of nodes -- to efficiently identify and formulate the building blocks of evolution. Accordingly, adaptive GNP is developed which self-adapts both crossover and mutation probabilities of each search variable to circumstances. The adaptation allows the automatic adjustment of evolution bias toward the frequently reused nodes in high-quality individuals. The adaptive GNP is compared with traditional GNP in a benchmark control testbed to evaluate its superiority.

1:50PM *Evolving Exact Integer Algorithms with Genetic Programming [#E-14155]*

Thomas Weise, Mingxu Wan, Ke Tang and Xin Yao, University of Science and Technology of China, China; The University of Birmingham, United Kingdom

The synthesis of exact integer algorithms is a hard task for Genetic Programming (GP), as it exhibits epistasis and deceptiveness. Most existing studies in this domain only target few and simple problems or test a small set of different representations. In this paper, we present the (to the best of our knowledge) largest study on this domain to date. We first propose a novel benchmark suite of 20 non-trivial problems with a variety of different features. We then test two approaches to reduce the impact of the negative features: (a) a new nested form of Transactional Memory (TM) to reduce epistatic effects by allowing instructions in the program code to be permutated with less impact on the program behavior and (b) our recently published Frequency Fitness Assignment method (FFA) to reduce the chance of premature convergence on deceptive problems. In a full-factorial experiment with six different loop instructions, TM, and FFA, we find that GP is able to

solve all benchmark problems, although not all of them with a high success rate. Several interesting algorithms are discovered. FFA has a tremendous positive impact while TM turns out not to be useful.

2:10PM *A Sequential Genetic Programming Method to Learn Forward Construction Heuristics for Order Acceptance and Scheduling [#E-14267]*

Su Nguyen, Mengjie Zhang and Mark Johnston, Victoria University of Wellington, New Zealand

Order acceptance and scheduling (OAS) is a hard optimisation problem in which both acceptance decisions and scheduling decisions must be considered simultaneously. Designing effective solution methods or heuristics for OAS is not a trivial task, especially to deal with different problem configurations and sizes. This paper proposes a new heuristic framework called forward construction heuristic (FCH) for OAS and develops a new sequential genetic programming (SGPOAS) method for automatic design of FCHs. The key idea of the new GP method is to learn priority rules directly from optimal scheduling decisions at different decision moments and evolve a set of rules for FCHs instead of a single rule as shown in previous studies. The results show that evolved FCHs are significantly better than evolved single priority rules. The evolved FCHs are also competitive with the existing meta-heuristics in the literature and very effective for large problem instances.

2:30PM *Anomaly Detection in Crowded Scenes Using Genetic Programming [#E-14372]*

Cheng Xie and Lin Shang, Nanjing University, China

Genetic programming(GP) has become an increasingly hot issue in evolutionary computation due to its extensive application. Anomaly detection in crowded scenes is also a hot research topic in computer vision. However, there are few contributions on using genetic programming to detect abnormalities in crowded scenes. In this paper, we focus on anomaly detection in crowded scenes with genetic programming. We propose a new method called Multi-Frame LBP Difference (MFLD) based on Local Binary Patterns(LBP) to extract pixel-level features from videos without additional complicated preprocessing operations such as optical flow and background subtraction. Genetic programming is employed to generate an anomaly detector with the extracted data. When a new video is coming, the detector can classify every frame and localize the abnormality to a single- pixel level in realtime. We validate our approach on a public dataset and compare our method with other traditional algorithms for video anomaly detection. Experimental results indicate that our method with genetic programming performs better in detecting abnormalities in crowded scenes.

2:50PM *A Genetic Programming Approach to Distributed QoS-Aware Web Service Composition [#E-14411]*

Yang Yu, Hui Ma and Mengjie Zhang, Victoria University of Wellington, New Zealand

Web service composition has emerged as a promising technique for building complex web applications, thus supporting business-to-business and enterprise application integration. Nowadays there are increasing numbers of web services are distributed across the internet. For a given service request there are many ways of service composition that can meet the service functional requirements (inputs and outputs) but have different qualities of Services (QoS), like response time or execution cost. QoS-aware web service composition seeks to find a service composition with optimized QoS properties. Genetic Programming is an efficient tool for tacking such optimization problems efficiently. This paper proposes a novel GP-based approach for distributed web service composition where multiple QoS constraints are considered simultaneously. A series of experiments have been conducted to evaluate the proposed approach with test data. The results show that our approach is efficient and effective to find a near-optimal service composition solution in the context of distributed service environment.

3:10PM *Generating Lambda Term Individuals in Typed Genetic Programming Using Forgetful A* [#E-14668]*

Tomas Kren and Roman Neruda, Charles Univetsity in Prague, Czech Republic; Academy of Sciences of the Czech Republic, Czech Republic

Tree based genetic programming (GP) traditionally uses simple S-expressions to represent programs, however more expressive representations, such as lambda calculus, can exhibit better results while being better suited for typed GP. In this paper we present population initialization methods within a framework of GP over simply typed lambda calculus that can be also used in the standard GP approach. Initializations can be parameterized by different search strategies, leading to wide spectrum of methods corresponding to standard ramped half-and-half initialization on one hand, or exhaustive systematic search on the other. A novel geometric strategy is proposed that balances those two approaches. Experiments on well known benchmark problems show that the geometric strategy outperforms the standard generating method in success rate, best fitness value, time consumption and average individual size.

ThE1-4 Heuristics, Metaheuristics and Hyper-heuristics I

Thursday, July 10, 1:30PM-3:30PM, Room: 203D, Chair: Graham Kendall

1:30PM *AIRP: A Heuristic Algorithm for Solving the Unrelated Parallel Machine Scheduling Problem [#E-14059]*

Luciano Perdigao Cota, Matheus Nohra Haddad, Marcone Jamilson Freitas Souza and Vitor Nazario Coelho, Federal University of Ouro Preto, Brazil; Fluminense Federal University, Brazil

This paper deals with the Unrelated Parallel Machine Scheduling Problem with Setup Times (UPMSPST). The objective is to minimize the makespan. In order to solve it, we propose a heuristic algorithm, based on Iterated Local Search (ILS), Variable Neighborhood Descent (VND) and Path Relinking (PR). In this algorithm, named AIRP, an initial solution is constructed using the Adaptive Shortest Processing Time method. This solution is refined by the ILS, having an adaptation of the VND as local search method. The PR method is applied as a strategy of intensification and diversification during the search. The algorithm was tested in instances of the literature envolving up to 150 jobs and 20 machines. The computational experiments show that the proposed algorithm outperforms an algorithm from the literature, both in terms of quality and variability of the final solution. In addition, the algorithm established new best solutions for more than 80,5% of the test problems in average.

1:50PM *Heuristic Space Diversity Management in a Meta-Hyper-Heuristic Framework [#E-14099]*

Jacomine Grobler, Andries Engelbrecht, Graham Kendall and V.S.S. Yadavalli, University of Pretoria, South Africa; University of Nottingham, United Kingdom

This paper introduces the concept of heuristic space diversity and investigates various strategies for the management of heuristic space diversity within the context of a meta-hyper- heuristic algorithm. Evaluation on a diverse set of floating-point benchmark problems show that heuristic space diversity has a significant impact on hyper-heuristic performance. The increasing heuristic space diversity strategies performed the best out of all strategies tested. Good performance was also demonstrated with respect to another popular multi-method algorithm and the best performing constituent algorithm.

2:10PM *An Improved Bilevel Evolutionary Algorithm Based on Quadratic Approximations [#E-14365]*

Ankur Sinha, Pekka Malo and Kalyanmoy Deb, Aalto University School of Business, Finland; Michigan State University, United States

In this paper, we provide an improved evolutionary algorithm for bilevel optimization. It is an extension of a recently proposed Bilevel Evolutionary Algorithm based on Quadratic Approximations (BLEAQ). Bilevel optimization problems are known to be difficult and computationally demanding. The recently proposed BLEAQ approach has been able to bring down the computational expense significantly as compared to the contemporary approaches. The strategy proposed in this paper further improves the algorithm by incorporating archiving and local search. Archiving is used to store the feasible members produced during the course of the algorithm that provide a larger pool of members for better quadratic approximations of optimal lower level solutions. Frequent local searches at upper level supported by the quadratic approximations help in faster convergence of the algorithm. The improved results have been demonstrated on two different sets of test problems, and comparison results against the contemporary approaches are also provided.

2:30PM *A Cooperative Approach between Metaheuristic and Branch-and-Price for the Team Orienteering Problem with Time Windows [#E-14467]*

Liangjun Ke, Xi'an Jiaotong University, China

The team orienteering problem with time windows (TOPTW) is a well studied routing problem. In this paper, a cooperative algorithm is proposed. It collaborates metaheuristic and branch-and-price. A restricted master problem and subproblem are defined. It uses a heuristic to obtain an integral solution for the restricted master problem and a metaheuristic to generate new columns for the subproblem. Experimental study shows that this algorithm can find new better solutions for several instances in short time, which supports the effectiveness of the cooperative mechanism between metaheuristic and branch-and-price.

2:50PM *Hyper-Heuristics with Penalty Parameter Adaptation for Constrained Optimization [#E-14524]*

Yu-Jun Zheng, Bei Zhang and Zhen Cheng, Zhejiang University of Technology, China

Penalty functions are widely used in constrained optimization, but determining optimal penalty parameters or weights turns out to be a difficult optimization problem itself. The paper proposes a hyper-heuristic approach, which searches the optimal penalty weight setting for low-level heuristics, taking the performance of those heuristics with specialized penalty weight settings as feedback to adjust the high-level search. The proposed approach can either be used for merely improving low-level heuristics, or be combined into a common hyper-heuristic framework for constrained optimization. Experiments on a set of well-known benchmark problems show that the hyper-heuristic approach with penalty parameter adaptation is effective in both aspects.

3:10PM *Control of Numeric and Symbolic Parameters with a Hybrid Scheme Based on Fuzzy Logic and Hyper-heuristics [#E-14652]*

Eduardo Segredo, Carlos Segura and Coromoto Leon, Universidad de La Laguna, Spain; CINVESTAV-IPN, Mexico

One of the main disadvantages of Evolutionary Algorithms (EAs) is that they converge towards local optima for some problems. In recent years, diversity-based multi-objective EAs have emerged as a promising technique to prevent from local optima stagnation when optimising single-objective problems. An additional drawback of EAs is the large dependency between the quality of the results provided and the setting of their parameters. By the use of parameter control methods, parameter values can be adapted during the run of an EA. The aim of control approaches is not only to improve the robustness of the controlled algorithm, but also to boost its efficiency. In this paper we apply a novel hybrid parameter control scheme based on Fuzzy Logic and Hyper-heuristics to simultaneously adapt several numeric and symbolic parameters of a diversity- based multi-objective EA. An extensive experimental evaluation is carried out, which includes a comparison between the hybrid control proposal and a wide range of configurations of the diversity-based multi-objective EA with fixed parameters. Results demonstrate that our control proposal is able to find similar or even better solutions than those obtained by the best configuration of the diversity-based scheme with fixed parameters in a significant number of benchmark problems, demonstrating the advantages of parameter control over parameter tuning for these test cases.

Industrial Session: ThE1-5 Computational Intelligence on Predictive Maintenance and Optimization

Thursday, July 10, 1:30PM-3:30PM, Room: 303, Chair: Shiji Song and Christoph Hametner

1:30PM *A Decomposition-Based Algorithm for Dynamic Economic Dispatch Problems [#E-14496]*

Eman Sayed, Daryl Essam, Ruhul Sarker and Saber Elsayed, University of New South Wales, Australia

Large scale constrained problems are complex problems due to their dimensionality, structure, in addition to their constraints. The performance of EAs decreases when the problem dimension increases. Decomposition-based EAs can overcome this drawback, but their performance would be affected if the interdependent variables were optimized in different subproblems. The use of EAs with variables interaction identification technique handles this issue by identifying better arrangements for decomposing a large problem into subproblems in a way that minimizes the interdependencies between them. The only technique in the literature that has been developed to identify the variables interdependency in constrained problems is the Variable Interaction Identification for Constrained problems (VIIC). This technique is tested in this paper on a real-world problem at three large dimensions which are large scale constrained optimization problems. The performance of the decomposition-based EA that uses VIIC is compared to Random Grouping approach for decomposition, for 5- Units, 10-Units, and 30-Units DED problems.

1:50PM *Minimizing Makespan for a No-Wait Flowshop Using Tabu Mechanism Improved Iterated Greedy Algorithm [#E-14497]*

Jianya Ding, Shiji Song, Rui Zhang and Cheng Wu, Tsinghua University, China; Nanchang University, China

This paper proposes a tabu mechanism improved iterated greedy (TMIIG) algorithm to solve the no-wait flowshop scheduling problem with makespan criterion. The motivation of seeking for further improvement in the iterated greedy (IG) algorithm framework is based on the observation that the construction phase of the original IG algorithm may lead to repeated search when applying the insertion neighborhood search. To overcome the drawback, we modified the IG algorithm by a tabu-based reconstruction strategy to enhance its exploitation ability. A powerful neighborhood search method which involves insert, swap, and double-insert moves is then applied

to obtain better soluions from the reconstructed solution in the previous step. Numerical computations verified the advantages of utilizing the new reconstruction scheme. In addition, comparisons with other high-performing algorithms demonstrated the effectiveness and robustness of the proposed algorithm.

2:10PM *Black-Hole PSO and SNO for Electromagnetic Optimization [#E-14659]*

Matteo Ruello, Francesco Grimaccia, Marco Mussetta and Riccardo E. Zich, Politecnico di Milano, Italy

In the past years Particle Swarm Optimization (PSO) has gained increasing attention for engineering and real-world applications. Among these, the design of antennas and electromagnetic devices is a well- established field of application. More recently, Social Network Optimization (SNO) has been introduced, inspired by the recent explosion of social networks and their capability to drive people's decision making process in everyday life. ``Black-hole'' is a novel operator, which is here considered for both PSO and SNO. It is based on the concept of repulsion among agents when they get stuck in local optima. The design of a planar array antenna is here addressed in order to assess its performances on a benchmark EM optimization problem. Reported results show its effectiveness in dealing with antenna optimization.

2:30PM *Dynamic Neural Networks for Jet Engine Degradation Prediction and Prognosis [#N-14508]*

S. Kiakojoori and K. Kiakojoori, Concordia University, Canada

In this paper, fault prognosis of aircraft jet engines are considered using computationally intelligent-based methodologies to ensure flight safety and performance. Two different dynamic neural networks namely, the nonlinear autoregressive neural networks with exogenous input (NARX) and the Elman neural networks are developed and designed for this purpose. The proposed dynamic neural networks are designed to capture the dynamics of two main degradations in the jet engine, namely the compressor fouling and the turbine erosion. The health status and condition of the engine is then predicted subject to occurrence of these deteriorations. In both proposed approaches, two scenarios are considered. For each scenario, several neural networks are trained and their performance in predicting multi-flights ahead turbine output temperature are evaluated. Finally, the most suitable neural network for prediction is selected by using the normalized Bayesian information criterion model selection. Simulation results presented demonstrate and illustrate the effective performance of our proposed neural network-based prediction and prognosis strategies.

2:50PM *Recognition of Sintering State in Rotary Kiln Using a Robust Extreme Learning Machine [#N-14894]*

Hua Chen, Jing Zhang, Xiaogang Zhang and Hongping Hu, Hunan University, China

Sintering is a key process for the industrial clinker production. The sintering state estimation in clinker is an essential factor for its process control. In this paper, a feature extraction method from flame image and a robust extreme learning machine (RB-ELM) classifier are provided to recognize sintering process in rotary kiln. After a preprocessing of image denoising and illumination compensation, material region of flame image is segmented by region growing algorithm and a 5-D statistic feature vector is extracted from it for the following classifier. In order to reduce the influence of outliers in training data caused by blurring image and to achieve a real-time application on site, a robust extreme learning machine, which adopted iterative weight least square (IWLS) method based on M-estimator, is used for fast classification of sintering state. Experimental results show that the proposed method can recognize sintering state accurately, quickly and robustly.

3:10PM *Model Based Lithium Ion Cell Ageing Data Analysis [#F-14177]*

Christoph Hametner, Wenzel Prochazka, Amra Suljanovic and Stefan Jakubek, Vienna University of Technology, Austria; AVL List GmbH, Austria

This paper reports the model based analysis of Lithium Ion cell ageing and the age-related adaptation of data driven battery models is addressed. To take account of ageing is an important issue e.g. for the battery management of (hybrid) electrical vehicles, in order to provide an exact online estimate of the state of charge (SoC). As a first step, ageing data analysis based on the architecture of local model networks (LMNs) is presented using data from a large scale ageing experiment of Lithium Ion cells. Additionally, the topic of time-variant battery modelling is addressed. Thus, the LMN is adapted in a way that age-related effects (such as capacity decay and resistance increase) are taken into account. Such a model can further be used for the design of a combined observer for SoC and state of health (SoH).

Thursday, July 10, 3:30PM-6:00PM

Poster Session: PE4 Poster Session IV

Thursday, July 10, 3:30PM-6:00PM, Room: Posters Area (Level 2), Chair: Tadahiko Murata

P701 *Dynamic Multi-Objective Optimization Using Charged Vector Evaluated Particle Swarm Optimization [#E-14378]*

Kyle Harrison, Beatrice Ombuki-Berman and Andries Engelbrecht, Brock University, Canada; University of Pretoria, South Africa

The vector evaluated particle swarm optimization (VEPSO) algorithm is a multi- swarm variation of the traditional particle swarm optimization (PSO) used to solve static multi-objective optimization problems (MOOPs). Recently, the dynamic VEPSO (DVEPSO) algorithm was proposed as an extension to VEPSO enabling the algorithm to handle dynamic MOOPs (DMOOPs). While DVEPSO has been successful at handling DMOOPs, the change detection mechanism relied on observing changes in objective space. An alternative strategy is proposed by using charged PSO (CPSO) sub-swarms with decision space change detection to address the outdated memory issue observed in vanilla PSO. This dynamic PSO variant allows for (implicit) decision space tracking not seen in DVEPSO while implicitly handling the diversity issue seen in dynamic environments. The proposed charged VEPSO is compared to DVEPSO on a wide variety of dynamic environment types. Results indicated that, in general, the proposed charged VEPSO outperformed the existing DVEPSO. Further, charged VEPSO exhibited better front-tracking abilities, while DVEPSO was superior with regards to locating the Pareto front.

P702 *A New Self-Adaptive PSO Based on the Identification of Planar Regions [#E-14753]*

Eddy Mesa, Juan David Velasquez and Patricia Jaramillo, Universidad Nacional de Colombia, Colombia

In this paper, we propose a new approach for self-adaptive particle swarm optimization, using the function's topology to adapt the parameters and modifying them when a planar region is identified in the objective function. Particle swarm optimization is a metaheuristic developed to optimize nonlinear problems. This metaheuristic has four parameters to adapt the search for the different optimization problems. However, finding an optimal set of parameters is not a trivial problem. Some strategies to adapt the

parameters have been developed, but they are not robust enough to cover all kinds of problems. Function's topology is one of the most decisive factors in order to choose a right set of parameters; i.e. convex functions need more exploitation because this topology offers a clear direction to the minimum point. In the opposite way, a noise function can be trapped in a local minimum for the same level of exploitation. In order to validate and compare our methods, we use the benchmark functions from CEC 2005 to compare the different particle swarm optimization versions. The results show that the proposed version is significant better than the original particle swarm optimization and the standard particle swarm optimization proposed in 2011.

P703 *PSO-Based Evacuation Simulation Framework [#E-14758]*

Pei-Chuan Tsai, Chih-Ming Chen and Ying-ping Chen, National Chiao Tung University, Taiwan

Evacuation simulation is a critical and important research issue for people to design safer building layouts or plan more effective evacuation routes. Many studies adopted methodologies in evolutionary computation into the evacuation simulation systems for finding better solutions. To simulate human behavior or crowd motion is one key factor to the practicality of the system. Particle swarm optimization algorithm (PSO), which is originated from the inspiration of bird flocking, is commonly applied to model human behavior. Based on the PSO-based human behavior simulation, many studies have got good results on evacuation simulation. However, the configurations of describing the experiment environment in the literature are complicated and specialized for certain specific scenarios. Observing the fact, we propose a new PSO-based simulation framework in order to provide a simple and general way to configure various simulation scenarios. This work adopts our previously proposed PSO-based crowd movement controlling mechanism and introduces new mechanisms to make the simulation fitting into evacuation circumstance more real. In the proposed framework, all people, obstacles, exits, and even the evacuation guide indicators are modeled as the original component of the PSO algorithm. It is convenient to setup the simulation environment upon the framework. Therefore, taking the proposed work as a research tool will be advantageous when the issue of evacuation simulation is investigated.

P704 *PSO-Based Update Memory for Improved Harmony Search Algorithm to the Evolution of FBBFNT' Parameters [#E-14189]*

Souhir Bouaziz, Adel M. Alimi and Ajith Abraham, University of Sfax, Tunisia; Machine Intelligence Research Labs, United States

In this paper, a PSO-based update memory for Improved Harmony Search (PSOUM-IHS) algorithm is proposed to learn the parameters of Flexible Beta Basis Function Neural Tree (FBBFNT) model. These parameters are the Beta parameters of each flexible node and the connected weights of the network. Furthermore, the FBBFNT's structure is generated and optimized by the Extended Genetic Programming (EGP) algorithm. The combination of the PSOUM-IHS and EGP in the same algorithm is so used to evolve the FBBFNT model. The performance of the proposed evolving neural network is evaluated for nonlinear systems of prediction and identification and then compared with those of related models.

P705 *Fuzzy Multiobjective Differential Evolution Using Performance Metrics Feedback [#E-14643]*

Chatkaew Jariyatantiwait and Gary Yen, Oklahoma State University, United States

Differential evolution is regarded as one of the most efficient evolutionary algorithms to tackle multiobjective optimization problems. The key to success of any multiobjective evolutionary algorithms (MOEAs) is maintaining a delicate balance between exploration and exploitation throughout the evolution process. In this paper, we propose a Fuzzy-based Multiobjective Differential Evolution (FMDE) that uses performance metrics, specifically, hypervolume, spacing, and maximum spread, to measure the state of the evolution process. We apply the inference rules to these metrics in order to dynamically adjust the associated control parameters of a chosen mutation strategy used in this algorithm. One parameter controls the degree of greedy or exploitation, while another regulates the degree of diversity or exploration of the reproduction phase. Therefore, we can appropriately adjust the degree of exploration and exploitation through performance feedback. The performance of FMDE is evaluated on well-known ZDT and DTLZ test suites in addition two representative functions in WFG. The results show that the proposed algorithm is competitive with respect to chosen state-of-the-art MOEAs.

P706 *Multiobjective Evolutionary Algorithm Portfolio: Choosing Suitable Algorithm for Multiobjective Optimization Problem [#E-14522]*

Shiu Yin Yuen and Xin Zhang, City University of Hong Kong, Hong Kong

The concept of algorithm portfolio has a long history. Recently this concept draws increasing attention from researchers, though most of the researches have concentrated on single objective optimization problems. This paper is intended to solve multiobjective optimization problems by proposing a multiple evolutionary algorithm portfolio. Differing from previous approaches, each component algorithm in our portfolio method has an independent population and the component algorithms do not communicate in any way with each other. Another difference is that our algorithm introduces no control parameters. This parameter-less characteristic is desirable as each additional parameter requires independent parameter tuning or control. A novel score calculation method,based on predicted performance, is used to assess the contributions of component algorithms during the optimization process. Such information is used by an algorithm selector which decides, for each generation, which algorithm to use. Experimental results show that our portfolio method outperforms individual algorithms in the portfolio. Moreover, it outperforms the AMALGAM method.

P707 *A Novel Algorithm for Many-Objective Dimension Reductions: Pareto-PCA-NSGA-II [#E-14266]*

Ronghua Shang, Kun Zhang and Licheng Jiao, Xidian University, China

Many-objective problem has more than 3 objectives. Because of the extraordinary difficulty of acquiring their Pareto optimal solutions directly, traditional methods will be out of operation for such problems. In recent years, many researchers have turned their attention to the study of this area. They are interested in two areas: acquiring some part of Pareto front which is useful to the researchers (Preferred Solutions) and reducing redundant objectives. In this paper, we combine two dimension reduction methods: the method based on Pareto optimal solution analysis and the method based on correlation analysis, to form a novel algorithm for dimension reduction. Firstly, the Pareto optimal solutions are acquired through NSGA-II. Then the objectives who contribute little to the number of non-dominated solutions are removed. At last, the dimension of objectives is reduced further according to their contribution to the principal component in PCA analysis. In this way, we can acquire the right non-redundant objectives with low time complexity. Simulation results show that the proposed algorithm can effectively reduce redundant objectives and keep the non-redundant objectives with low time.

P708 *An Experimental Analysis of Evolutionary Algorithms for the Three-Objective Oil Derivatives Distribution Problem [#E-14755]*

Thatiana Souza, Elizabeth Goldbarg and Marco Goldbarg, Federal University of Rio Grande do Norte, Brazil

Scheduling oil derivatives distribution by multi-product pipelines is an important problem faced by the petroleum industry. Some researchers deal with it as a discrete problem where batches of products flow in a network. Minimizing delivery time is a usual objective handled by engineers when dealing with this problem. Nevertheless, other important costs may also be considered such as losses due to interfaces between fluids and electrical energy. Losses due to interfaces occur when different products sent consecutively contaminate each other. The price paid for electrical energy

varies during the day, so it is important also to try to minimize this cost. In this paper, these three objectives, i.e. delivery time, interface losses and electricity cost, are minimized simultaneously. Two hybridizations of transgenetic algorithms with well-known multi-objective evolutionary algorithms are proposed. One is derived from the NSGA-II framework, named NSTA, and the other is derived from the MOEA/D framework, named MOTA/D. To analyze the performance of the proposed algorithms, they are compared with their classical counterparts and applied to thirty random instances. It is also the first time MOEA/D is applied to the investigated problem. Statistical tests indicate that the MOTA/D generated better approximation sets than the other algorithms. Therefore, the MOTA/D encourages further researches in the hybridization of transgenetic algorithms and evolutionary multi-objective frameworks, specifically those based on decomposition.

P709 *A New Strategy for Finding Good Local Guides in MOPSO [#E-14472]*

Man Fai Leung, Sin Chun Ng, Chi Chung Cheung and Andrew K Lui, The Open University of Hong Kong, Hong Kong; The Hong Kong Polytechnic University, Hong Kong

This paper presents a new algorithm that extends Particle Swarm Optimization (PSO) to deal with multi-objective problems. It makes two main contributions. The first is that the square root distance (SRD) computation among particles and leaders is proposed to be the criterion of the local best selection. This new criterion can make all swarms explore the whole Pareto-front more uniformly. The second contribution is the procedure to update the archive members. When the external archive is full and a new member is to be added, an existing archive member with the smallest SRD value among its neighbors will be deleted. With this arrangement, the non-dominated solutions can be well distributed. Through the performance investigation, our proposed algorithm performed better than two well- known multi-objective PSO algorithms, MOPSO-sigma and MOPSO-CD, in terms of different standard measures.

P710 *An Inter-Molecular Adaptive Collision Scheme for Chemical Reaction Optimization [#E-14035]*

James J.Q. Yu, Victor O.K. Li and Albert Y.S. Lam, The University of Hong Kong, Hong Kong; Hong Kong Baptist University, Hong Kong

Optimization techniques are frequently applied in science and engineering research and development. Evolutionary algorithms, as a kind of general-purpose metaheuristic, have been shown to be very effective in solving a wide range of optimization problems. A recently proposed chemical-reactioninspired metaheuristic, Chemical Reaction Optimization (CRO), has been applied to solve many global optimization problems. However, the functionality of the inter-molecular ineffective collision operator in the canonical CRO design overlaps that of the on-wall ineffective collision operator, which can potential impair the overall performance. In this paper we propose a new inter-molecular ineffective collision operator for CRO for global optimization. To fully utilize our newly proposed operator, we also design a scheme to adapt the algorithm to optimization problems with different search space characteristics. We analyze the performance of our proposed algorithm with a number of widely used benchmark functions. The simulation results indicate that the new algorithm has superior performance over the canonical CRO.

P711 *Analysis of Constraint Handling Methods for the Gravitational Search Algorithm [#E-14116]*

Daniel Poole, Christian Allen and Thomas Rendall, University of Bristol, United Kingdom

The gravitational search algorithm (GSA) is a recent addition to the family of global optimization algorithms based on phenomena found in nature, specifically the gravitational attractive force between two bodies of mass. However, like almost all global search algorithms of this type, GSA has no direct method of handling a constrained optimization problem. There has been much attention to constraint handling using other agent based systems, though the mechanics of GSA make the application of many of these difficult. This paper has therefore analysed constraint handling methods for use with GSA and compared the performance of simple to implement methods (penalties and feasible directions) with a novel separation-sub-swarm (3S) approach, and found that feasible direction methods ideally need at least one initially feasible particle, and that the novel 3S approach is highly effective for solving constrained optimization problems using GSA outperforming the other approaches tested.

P712 *Distributed Wireless Sensor Scheduling for Multi-Target Tracking Based on Matrix-Coded Parallel Genetic Algorithm [#E-14479]*

Zixing Cai, Sha Wen and Lijue Liu, Central South University, China

The aim of designing a sensor scheduling scheme for target tracking in wireless sensor network is to improve the tracking accuracy, balance the network energy and prolong the network lifespan. It is viewed as a multi-objective optimization problem. A modified matrix-coded parallel genetic algorithm (MPGA) is proposed in which multiple subpopulations evolve synchronously and satify the specific constraint arised from the senario of multi-target tracking that a sensor can only track just one target. Simulation results show that MPGA, compared with traditional genetic algorithm, converges to the better result with higher speed when applied in multi-target tracking in wireless sensor network. And our proposed distributed sensor scheduling scheme based on MPGA outperforms than existed schemes.

P713 *Effect of Pseudo Gradient on Differential Evolutionary for Global Numerical Optimization [#E-14511]*

Jinliang Ding, Lipeng Chen, Qingguang Xie, Tianyou Chai and Xiuping Zheng, Northeastern University, China

In this paper, a novel pseudo gradient based DE approach is proposed, which takes advantage of both the differential evolutionary (DE) and the gradient-based algorithm. The gradient information, which is called pseudo gradient, is generated through randomly selected two vectors and their fitness function values. This work is to investigate the effect of proposed pseudo gradient on differential volutionary algorithm. The simulation results show that DE with pseudo gradient can obtain better performance overall in comparison with classical DE variants. The pseudo gradient based DE with adaptive parameter section is compared with the existing adaptive DE algorithms. Also, the control parameter, step size are investigated to understand the mechanism of pseudo gradient in detail.

P714 *Protein Folding Estimation Using Paired-Bacteria Optimizer [#E-14518]*

Mengshi Li, Tianyao Ji, Peter Wu, Shan He and Qinghua Wu, South China University of Technology, China; Shenzhen Institute of Advanced Technology, China; University of Birmingham, United Kingdom

Protein folding estimation attracts a large attention in the area of computational biology, due to its benefits on medical research and the challenge of NP-hard objective functions. In order to simulate the protein folding procedure and estimate the structure of the protein after folding, this paper adopts a Paired-Bacteria Optimizer (PBO), which is a biologically-inspired optimization algorithm. Compared with most Evolutionary Algorithms (EAs), the computational complexity of PBO is much less. Therefore, it is suitable to be applied to solve NP-hard problem. The experimental studies is performed on several benchmark lattice protein combination. The experimental results demonstrated that PBO is able to estimate the folded protein structure with a superior convergence.

P715 *A Self-Adaptive Group Search Optimizer with Elitist Strategy [#E-14530]*

Xiang-wei Zheng, Dian-jie Lu and Zhen-hua Chen, Shandong Normal University, China

To deal with the disadvantages of Group Search Optimizer (GSO) as slow convergence, easy entrapment in local optima and failure to use history information, a Self-adaptive Group Search Optimizer with Elitist strategy (SEGSO) is proposed in this paper. To maintain the group diversity, SEGSO employs a self- adaptive role assignment strategy, which determines whether a member is a scrounger or a ranger based on ConK consecutive iterations of the producer. On the other hand, scroungers are updated with elitist strategy based on simulated annealing by using history information to improve convergence and guarantee SEGSO to remain global search. Experimental results demonstrate that SEGSO outperform particle swarm optimizer and original GSO in convergence rate and escaping from local optima.

P716 *Optimization Based on Adaptive Hinging Hyperplanes and Genetic Algorithm [#E-14535]*

Jun Xu, Xiangming Xi and Shuning Wang, China University of Petroleum, China; Tsinghua University, China

This paper describes an optimization strategy based on the model of adaptive hinging hyperplanes (AHH) and genetic algorithm (GA). The sample points of physical model are approximated by the AHH model, and the resulting model is minimized using a modified GA. In the modified GA, each chromosome corresponds to a local optimum. A criterion based on γ-valid cut is used to judge whether the global optimum is reached. Simulation results show that if the parameters are carefully chosen, the global optimum of AHH minimization is close to the optimum of the original function.

P717 *Combining Multipopulation Evolutionary Algorithms with Memory for Dynamic Optimization Problems [#E-14557]*

Tao Zhu, Wenjian Luo and Lihua Yue, University of Science and Technology of China, China

Both multipopulation and memory are widely used approaches in the field of evolutionary dynamic optimization. It would be interesting to examine the effect of the combinations of multipopulation algorithms (MPAs) and memory schemes. However, since most of the existing memory schemes are proposed with single population algorithms, straightforwardly applying them to MPAs may cause problems. By addressing the possible problems, a new memory scheme is proposed for MPAs in this paper. In the experiments, several existing memory schemes and the newly proposed scheme are combined with a MPA, i.e. the Species-based Particle Swarm Optimizer (SPSO), and these combinations are tested on cyclic and acyclic problems. The experimental results indicate that 1) straightforwardly using the existing memory schemes sometimes degrades the performance of SPSO even on cyclic problems; 2) the newly proposed memory scheme is very competitive.

P718 *Micro-Differential Evolution with Vectorized Random Mutation Factor [#E-14768]*

Hojjat Salehinejad, Shahryar Rahnamayan and Hamid R. Tizhoosh, University of Ontario Institute of Technology, Canada; University of Waterloo, Canada

One of the main disadvantages of population-based evolutionary algorithms (EAs) is their high computational cost due to the nature of evaluation, specially when the population size is large. The micro-algorithms employ a very small number of individuals, which can accelerate the convergence speed of algorithms dramatically, while it highly increases the stagnation risk. One approach to overcome the stagnation problem can be increasing the diversity of the population. To do so, a microdifferential evolution with vectorized random mutation factor (MDEVM) algorithm is proposed in this paper, which utilizes the small size population benefit while preventing stagnation through diversification of the population. The proposed algorithm is tested on the 28 benchmark functions provided at the IEEE congress on evolutionary computation 2013 (CEC-2013). Simulation results on the benchmark functions demonstrate that the proposed algorithm improves the convergence speed of its parent algorithm.

P719 *Application of BPSO with GA in Model-Based Fault Diagnosis of Traction Substation [#E-14345]*

Song Gao, Zhigang Liu, Chenxi Dai and Xiao Geng, Southwest Jiaotong University, China

In this paper, a hybrid evolutionary algorithm based on Binary Particle Swarm Optimization (BPSO) and Genetic Algorithm (GA) is proposed to compute the minimal hitting sets in model-based diagnosis. And a minimal assurance strategy is proposed to ensure that the final output of algorithm is the minimal hitting sets. In addition, the logistic mapping of chaos theory is adopted to avoid the local optimum. The high efficiency of new algorithm is proved through comparing with other algorithms for different problem scales. Additionally, the new algorithm with logistic mapping could improve the realization rate to almost 100% from 96%. At last, the new algorithm is used in the model-based fault diagnosis of traction substation. The results show that the new algorithm makes full use of the advantages of GA and BPSO and finds all the minimal hitting sets in 0.2369s, which largely meet the real-time requirement of fault diagnosis in the traction substation.

P720 *Performance of AI Algorithms for Mining Meaningful Roles [#E-14227]*

Xuanni Du and Xiaolin Chang, Beijing Jiaotong University, China

Role-based access control (RBAC) is being today's dominant access control model due to its potential to mitigate the complexity and cost of access control administration. However, the migration from the access control lists (ACL) to RBAC for a large administration system may consume significant efforts, which challenges the adoption of RBAC. Role mining algorithms can significantly reduce the migration cost by providing a partially automatic construction of an RBAC policy.This paper explores Artificial Intelligence (AI) techniques in designing role mining algorithms, which can optimize policy quality in terms of policy size, user-attribute-based interpretability of the roles, and the combination of size and interpretability. We propose two algorithms, genetic algorithm (GA)-based and ant colony optimization (ACO)-based. GA-based algorithm works by starting with a set of all candidate roles and repeatedly removing roles. ACO-based algorithm works by starting with an empty policy and repeatedly adding candidate roles. We carry out extensive experiments with publicly available access control policies. The simulation results indicate that (1) the proposed algorithms achieves better performance than the corresponding existing algorithms. (2) GA-based approach produces better results than ACO-based approach.

P721 *Using Estimation of Distribution Algorithm to Coordinate Decentralized Learning Automata for Meta-Task Scheduling [#E-14429]*

Jie Li and Junqi Zhang, Tongji University, China

Learning automaton (LA) is a reinforcement learning model that aims to determine the optimal action out of a set of actions. It is characterized by updating a selection probability set through a sequence of repetitive feedback cycles interacting with an environment. Decentralized learning automata (DLAs) consist of many learning automata (LAs) that learn at the same time. Each LA independently selects an action based on its own selection probability set. In order to provide an appropriate central coordination mechanism in DLAs, this paper proposes a novel decentralized coordination learning automaton (DCLA) using a new selection probability set which is combined with the probability sets derived from both LA and estimation of distribution algorithm (EDA). LA contributes to the own learning experience of each LA while EDA estimates the distribution of the whole swarm's promising individuals. Thus, decentralized LAs can be coordinated by EDA using the swarm's comprehensive knowledge. The proposed automaton is applied to solve the real problem of meta-task scheduling in heterogeneous computing system. Extensive experiments demonstrate a superiority of DCLA over other counterpart algorithms. The results show that the proposed DCLA provides

an effective and efficient way to coordinate LAs for solving complicated problems.

P722 *A Modular Approach for Query Spotting in Document Images and Its Optimization Using Genetic Algorithms [#E-14528]*

Houssem Chatbri, Paul Kwan and Keisuke Kameyama, University of Tsukuba, Japan; University of New England, Australia

Query spotting in document images is a subclass of Content-Based Image Retrieval (CBIR) algorithms concerned with detecting occurrences of a query in a document image. Due to noise and complexity of document images, spotting can be a challenging task and easily prone to false positives and partially incorrect matches, thereby reducing the overall precision of the algorithm. A robust and accurate spotting algorithm is essential to our current research on sketch-based retrieval of digitized lecture materials. We have recently proposed a modular spotting algorithm in [Chatbri et al., 2014]. Compared to existing methods, our algorithm is both application-independent and segmentation-free. However, it faces the same challenges of noise and complexity of images. In this paper, inspired by our earlier research on optimizing parameter settings for CBIR using an evolutionary algorithm [Kameyama et al., 2006][Okayama et al., 2008], we introduce a Genetic Algorithm-based optimization step in our spotting algorithm to improve each spotting result. Experiments using an image dataset of journal pages reveal promising performance, in that the precision is significantly improved but without compromising the recall of the overall spotting result.

P723 *An Improved Genetic Algorithm for Dynamic Shortest Path Problems [#E-14568]*

Xuezhi Zhu, Wenjian Luo and Tao Zhu, University of Science and Technology of China, China

The shortest path (SP) problems are conventional combinatorial optimization problems. There are many deterministic algorithms solving the shortest path problems in static topologies. However, in dynamic topologies, these deterministic algorithms are not efficient due to the necessity of restart, while genetic algorithms (GAs) are good at solving dynamic optimization problems (DOPs). In this paper, an improved GA with four local search operators for dynamic shortest path (DSP) problems is proposed. The local search operators are inspired by Dijkstra's Algorithm and carried out when the topology changes to generate local shortest path trees, which are used to enhance the performance of the individuals in the population. The experimental results show that the proposed algorithm could obtain the solutions which adapt to new environments rapidly and produce high-quality solutions after environmental changes.

P724 *A Novel Genetic Algorithm Considering Measures and Phrases for Generating Melody [#E-14591]*

Chia-Lin Wu, Chien-Hung Liu and Chuan-Kang Ting, National Chung Cheng University, Taiwan

Composing music through evolutionary algorithms has received increasing attention recently. To establish a standard of composing, some studies were proposed on the basis of analysis on musicians, statistics of music details, and rule of thumbs. These methods have achieved some promising results; however, generating melody is still a formidable challenge to computer composition because of the considerable permutations of notes. This study develops a genetic algorithm (GA) based on music theory to generate melody. In particular, we use the rhythm of existing songs as the basis to generate new compositions instead of generating music from scratch; that is, the GA keeps the rhythm of an existing song and rearranges the pitches of all notes for a new composition. Three crossover operators are further proposed to improve the performance of GA on composition. The experimental results show that the GA can achieve satisfactory compositions. The three crossover operators outperform 2-point crossover in the fitness of resultant compositions.

P725 *Optimal Sizing of DGs and Storage for Microgrid with Interruptible Load Using Improved NSGA-II [#E-14408]*

Zhe Shi, Yonggang Peng and Wei Wei, Zhejiang University, China

The rapid development of distributed generation (DG) has deeply transferred the power utilization style. Microgrid is developed for better absorption of distributed generation and has been researched in recent years. Interruptible load (IL) is another method to absorb the randomness and waviness of wind and solar energy, and is considered in this paper for more reliable and efficient deployment of DGs and storage in microgrid. A multi-objective optimization model is proposed for microgrid power sources construction with distributed generation, storage and interruptible load. Objectives of the model are economic cost, environmental cost and annual interruption duration. The model is solved by employing improved NSGA-II with the input of temperature, light intensity, wind speed, and load curve. The case study shows that the Pareto optimal front which covers the optimal solutions under different circumstances is effectively obtained. Thus the supervisor can select the final scheme with full consideration of different objectives. The impacts of IL on economic and environmental cost are also analyzed and demonstrated with many aspects.

P726 *Lion Algorithm for Standard and Large Scale Bilinear System Identification: A Global Optimization Based on Lion's Social Behavior [#E-14694]*

B. R. Rajakumar, Aloy Labs, India

Nonlinear system identification process, especially bilinear system identification process exploits global optimization algorithms for betterment of identification precision. This paper attempts to introduce a new optimization algorithm called as Lion algorithm to accomplish the system characteristics precisely. Our algorithm is a simulation model of the lion's unique characteristics such as territorial defense, territorial takeover, laggardness exploitation and pride. Experiments are conducted by identifying a nonlinear rationale digital benchmark system using standard bilinear model and comparisons are made with prominent genetic algorithm and differential evolution. Subsequently, curse of dimensionality is also experimented by defining a large scale bilinear model, i.e. bilinear system with 1023 bilinear kernel models, to identify the same digital benchmark system. Lion algorithm dominates when using standard bilinear model, whereas it is equivalent to differential evolution and better than genetic algorithm when using large scale bilinear model.

P727 *Intelligent Search Optimized Edge Potential Function (EPF) Approach to Synthetic Aperture Radar (SAR) Scene Matching [#E-14373]*

Yifei Wang and Jihao Yin, University of Bath, United Kingdom; Beihang University, China

Research on synthetic aperture radar (SAR) scene matching in the aircraft end- guidance has a significant value for both research and real-world application. The conventional scene matching methods, however, suffer many disadvantages such as heavy computation burden and low convergence rate so that these methods cannot meet the requirement of end-guidance system in terms of fast and real-time data processing. Furthermore, there are complex noises in the SAR image, which also compromise the effectiveness of using the conventional scene matching methods. To address the above issues, in this paper, the intelligent optimization method, Free Search with Adaptive Differential Evolution Exploitation and Quantum-Inspired Exploration, has been introduced to tackle the SAR scene matching problem. We first establish the effective similarity measurement function for target edge feature matching through introducing the edge potential function (EPF) model. Then, a new method, ADEQFS-EPF, has been proposed for SAR scene matching. In ADEQFS-EPF, the previous studied theoretical model, ADEQFS, is combined with EPF model. We also employed three recent proposed evolutionary algorithms to compare against the proposed method on optical and SAR datasets. The experiments based on Matlab simulation have verified the effectiveness of the application of ADEQFS and EPF model to the field of SAR scene matching.

Thursday, July 10, 4:00PM-6:00PM

ThE2-1 Multi-Objective Evolutionary Algorithms II

Thursday, July 10, 4:00PM-6:00PM, Room: 203A, Chair: Robin Purshouse

4:00PM *A Replacement Strategy for Balancing Convergence and Diversity in MOEA/D [#E-14220]*

Zhenkun Wang, Qingfu Zhang, Maoguo Gong and Aimin Zhou, Xidian University, China; University of Essex, United Kingdom; East China Normal University, China

This paper studies the replacement schemes in MOEA/D and proposes a new replacement named global replacement. It can improve the performance of MOEA/D. Moreover, trade-offs between convergence and diversity can be easily controlled in this replacement strategy. It shows that different problems need different trade-offs between convergence and diversity. We test the MOEA/D with this global replacement on three sets of benchmark problems to demonstrate its effectiveness.

4:20PM *A Test Problem for Visual Investigation of High-Dimensional Multi-Objective Search [#E-14192]*

Miqing Li, Shengxiang Yang and Xiaohui Liu, Brunel University, United Kingdom; De Montfort University, United Kingdom

An inherent problem in multiobjective optimization is that the visual observation of solution vectors with four or more objectives is infeasible, which brings major difficulties for algorithmic design, examination, and development. This paper presents a test problem, called the Rectangle problem, to aid the visual investigation of high-dimensional multiobjective search. Key features of the Rectangle problem are that the Pareto optimal solutions 1) lie in a rectangle in the two-variable decision space and 2) are similar (in the sense of Euclidean geometry) to their images in the four-dimensional objective space. In this case, it is easy to examine the behavior of objective vectors in terms of both convergence and diversity, by observing their proximity to the optimal rectangle and their distribution in the rectangle, respectively, in the decision space. Fifteen algorithms are investigated. Underperformance of Pareto-based algorithms as well as most state-of-the-art many-objective algorithms indicates that the proposed problem not only is a good tool to help visually understand the behavior of multiobjective search in a high-dimensional objective space but also can be used as a challenging benchmark function to test algorithms' ability in balancing the convergence and diversity of solutions.

4:40PM *MD-MOEA : A New MOEA Based on the Maximin Fitness Function and Euclidean Distances between Solutions [#E-14180]*

Adriana Menchaca-Mendez and Carlos A. Coello Coello, CINVESTAV-IPN, Mexico

In this paper, we propose a new selection mechanism based on the maximin fitness function and a technique based on Euclidean distances between solutions to improve the diversity of the population in objective function space. Our new selection mechanism is incorporated into a multi-objective evolutionary algorithm (MOEA) which uses the operators of NSGA-II (crossover and mutation) to generate new individuals, giving rise to the so-called "Maximin-Distances Multi-Objective Evolutionary Algorithm (MD-MOEA)". Our MD-MOEA is validated using standard test functions taken from the specialized literature, having three to six objective functions. MD-MOEA is compared with respect to MC-MOEA (which is based on the maximin fitness function and a clustering technique), MOEA/D using Penalty Boundary Intersection (PBI), which is based on decomposition, and SMS-EMOA-HYPE (a version of SMS-EMOA that uses a fitness assignment based on the use of an approximation of the hypervolume indicator). Our preliminary results indicate that our MD-MOEA is a good alternative to solve multi-objective optimization problems having both low dimensionality and high dimensionality in objective function space because it obtains better results than MC-MOEA and MOEA/D in most cases and it is competitive with respect to SMS-EMOA-HYPE (in fact, it outperforms SMS-EMOA-HYPE in problems of high dimensionality) but at a much lower computational cost.

5:00PM *Multiobjective Test Problems with Complicated Pareto Fronts: Difficulties in Degeneracy [#E-14476]*

Hui Li, Qingfu Zhang and Jingda Deng, Xi'an Jiaotong University, China; City University of Hong Kong, Hong Kong

It is well-established that the shapes of Pareto-optimal fronts (POFs) can affect the performance of some multiobjective optimization methods. The most well-known characteristics on the shape of POFs are convexity and discontinuity. In this paper, we investigate the construction of multiobjective test problems with complicated POFs, of which its local parts could have mixed dimensionalities. For example, in the case of 3 objectives, some parts of POFs can be 1-D curves while others could be 2-D surfaces. We formulate eight test problems, called CPFT1-8, with such a feature. To study the difficulties of these test problems, we conducted some experiments with two state-of-the- art algorithms MOEA/D and NSGA-II, and analyzed their performances.

5:20PM *A Comparison Study of Binary Multi-Objective Particle Swarm Optimization Approaches for Test Case Selection [#E-14623]*

Luciano Souza, Ricardo Prudencio and Flavia Barros, IFNMG, Brazil; CIn/UFPE, Brazil

During the software testing process many test suites can be generated in order to evaluate and assure the quality of the products. In some cases the execution of all suites can not fit the available resources (time, people, etc). Hence, automatic Test Case (TC) selection could be used to reduce the suites based on some selection criterion. This process can be treated as an optimization problem, aiming to find a subset of TCs which optimizes one or more objective functions (i.e., selection criteria). The majority of search-based works focus on single-objective selection. In this light, we developed mechanisms for functional TC selection which considers two objectives simultaneously: maximize requirements' coverage while minimizing cost in terms of TC execution effort. These mechanisms were implemented by deploying multi-objective techniques based on Particle Swarm Optimization (PSO). Due to the drawbacks of original binary version of PSO we implemented five binary PSO algorithms and combined them with a multi-objective versions of PSO in order to create new optimization strategies applied to TC selection. The experiments were performed on two real test suites, revealing the feasibility of the proposed strategies and the differences among them.

5:40PM *The Effect of Different Local Search Algorithms on the Performance of Multi-Objective Optimizers [#E-14665]*

Martin Pilat and Roman Neruda, Charles University in Prague, Czech Republic; Academy of Sciences of the Czech Republic, Czech Republic

Several contemporary multi-objective surrogate-based algorithms use some kind of local search operator. The search technique used in this operator can

largely affect the performance of the multi-objective optimizer as a whole, however, little attention is often paid to the selection of this technique. In this paper, we compare three different local search techniques and evaluate their effect on the performance of two different surrogate based multi-objective optimizers. The algorithms are evaluated using the well known ZDT and WFG benchmark suites and recommendations are made based on the results.

ThE2-2 Cultural Algorithms and Knowledge Extraction in Evolutionary Algorithms

Thursday, July 10, 4:00PM-6:00PM, Room: 203B, Chair: Robert G. Reynolds

4:00PM *Cultural Algorithms Applied to the Evolution of Robotic Soccer Team Tactics: A Novel Perspective [#E-14785]*

Mostafa Ali, Abdulmalik Morghem, Jafar AlBadarneh, Rami Al-Gharaibeh, Ponnuthurai Nagaratnam Suganthan and Robert G. Reynolds, Jordan University of Science and Technology, Jordan; Nanyang Technological University, Singapore; Wayne State University, United States

Cultural Algorithms have been previously employed to model the emergence of cooperative behaviors of agents in different multi-agent systems. In this paper, a simplified and adaptive version will be used as the basis to generate cooperative behaviors within a team of soccer players using different team formations and effective plays. This system can be used as a tutorial for the application of Cultural Algorithms for the coordination of groups of agents in complex multi-agent dynamic environments. Simplified Cultural Algorithms were successful in effectively learning different types of plays, including active and passive protagonists, within a small number of generations. Successful learning includes the coordination of adjustments of the team members to develop the most suitable team formations for every scenario. Experimental results enable us to conclude that Cultural Algorithms, when configured properly, in order to produce significant results, can perform very competitively when compared to other types of learning strategies and case-based game plays.

4:20PM *Cultural Learning for Multi-Agent System and Its Application to Fault Management [#E-14448]*

Teran Juan, Aguilar Jose and Cerrada Mariela, Universidad de Los Andes, Venezuela

It is usually agreed that a system capable of learning deserves to be called intelligent; and conversely, a system being considered as intelligent is, among other things, usually expected to be able to learn. Learning always has to do with the self-improvement of future behavior based on past experience. In this paper we present a learning model for Multi-Agent System, which aims to the optimization of coordination schemes through a collective learning process based on Cultural Algorithms.

4:40PM *Analyzing Prehistoric Hunter Behavior with Cultural Algorithms [#E-14717]*

Samuel Stanley, Thomas Palazzolo and David Warnke, Wayne State University, United States

This paper details a cultural algorithm (CA) system designed to assist archaeological expedition teams in the task of finding historic artifacts. In our system, the goals that the agents are trying to achieve continuously change as the environment changes. We are thus able to simulate the real-world challenge of a dynamic environment that human cultures must deal with and react to, making our system a very useful tool for finding the archaeological remains of such cultures. Although it is very new, our system has already had yielded promising results in the service of Dr. John O'Shea's Lake Huron expedition team which is studying the prehistoric Alpena-Amberley Land Bridge. We hope to use it to assist other expeditions as well in the near future.

5:00PM *GSCA: Reconstructing Biological Pathway Topologies Using a Cultural Algorithms Approach [#E-14851]*

Thair Judeh, Thaer Jayyousi, Lipi Acharya, Robert G. Reynolds and Dongxiao Zhu, Wayne State University, United States; Dow AgroSciences LLC, United States

With the increasing availability of gene sets and pathway resources, novel approaches that combine both resources to reconstruct networks from gene sets are of interest. Currently, few computational approaches explore the search space of candidate networks using a parallel search. In particular, search agents employed by evolutionary computational approaches may better escape false peaks compared to previous approaches. It may also be hypothesized that gene sets may model signal transduction events, which refer to linear chains or cascades of reactions starting at the cell membrane and ending at the cell nucleus. These events may be indirectly observed as a set of unordered and overlapping gene sets. Thus, the goal is to reverse engineer the order information within each gene set to reconstruct the underlying source network using prior knowledge to limit the search space. We propose the Gene Set Cultural Algorithm (GSCA) to reconstruct networks from unordered gene sets. We introduce a robust heuristic based on the arborescence of a directed graph that performs well for random topological sort orderings across gene sets simulated for four E. coli networks and five Insilico networks from the DREAM3 and DREAM4 initiatives, respectively. Furthermore, GSCA performs favorably when reconstructing networks from randomly ordered gene sets for the aforementioned networks. Finally, we note that from a set of 23 gene sets discretized from a set of 300 S. cerevisiae expression profiles, GSCA reconstructs a network preserving most of the weak order information found in the KEGG Cell Cycle pathway, which was used as prior knowledge.

5:20PM *A Social Metrics Based Process Model on Complex Social System [#E-14856]*

Xiangdong Che and Robert G. Reynolds, Eastern Michigan University, United States; Wayen State University, United States

In previous work, we investigated the performance of Cultural Algorithms (CA) over the complete range of system complexities in a benchmarked environment. In this paper the goal is to discover whether there is a similar internal process going on in CA problem solving, regardless of the complexity of the problem. We are to monitor the "vital signs" of a cultural system during the problem solving process to determine whether it was on track or not and infer the complexity class of a social system based on its "vital signs". We first demonstrate how the learning curve for a Cultural System is supported by the interaction of the knowledge sources. Next a circulatory system metaphor is used to describe how the exploratory knowledge sources generate new information that is distributed to the agents via the Social Fabric network. We then conclude that the Social Metrics are able to indicate the progress of the problem solving in terms of its ability to periodically lower the innovation cost for the performance of a knowledge source which allows the influenced population to expand and explore new solution possibilities as seen in the dispersion metric. Hence we present the possibility to assess the complexity of a system's environment by looking at the Social Metrics.

5:40PM *Online Knowledge-Based Evolutionary Multi-Objective Optimization [#E-14774]*

Bin Zhang, Kamran Shafi and Hussein Abbass,
University of New South Wales, Australia

Knowledge extraction from a multi-objective optimization process has important implications including a better understanding of the optimization process and the relationship between decision variables. The extant approaches, in this respect, rely on processing the post-optimization Pareto sets for automatic rule discovery using statistical or machine learning methods. However such approaches fall short of providing any information during the progress of the optimization process, which can be critical for decision analysis especially if the problem is dynamic. In this paper, we present a multi-objective optimization framework that uses a knowledge-based representation to search for patterns of Pareto optimal design variables instead of conventional point form solution search. The framework facilitates the online discovery of knowledge during the optimization process in the form of interpretable rules. The core contributing idea of our research is that we apply multi-objective evolutionary process on a population of bounding hypervolumes, or rules, instead of evolving individual point-based solutions. The framework is generic in a sense that any existing multi-objective optimization algorithm can be adapted to evaluate the rule quality based on the sampled solutions from the bounded space. An instantiation of the framework using hyperrectangular representation and nondominated sorting based rule evaluation is presented in this paper. Experimental results on a specifically designed test function as well as some standard test functions are presented to demonstrate the working and convergence properties of our algorithm.

Special Session: ThE2-3 Single Objective Numerical Optimization III

Thursday, July 10, 4:00PM-6:00PM, Room: 203C, Chair: Ponnuthurai Nagaratnam Suganthan and Qin Chen

4:00PM *Controlled Restart in Differential Evolution Applied to CEC2014 Benchmark Functions [#E-14823]*

Radka Polakova, Josef Tvrdik and Petr Bujok,
University of Ostrava, Czech Republic

A controlled restart in differential evolution (DE) is proposed. The conditions of restart are derived from the difference of maximum and minimum values of the objective function and the estimated maximum distance among the points in the current population. The restart is applied in a competitive-adaptation variant of DE. This DE algorithm with the controlled restart is used in the solution of the benchmark problems defined for the CEC 2014 competition. Two control parameters of restart are set up intuitively. The population size, which is the only control parameter of competitive-adaptation variant of DE, is set up to the values based on a short preliminary experimentation.

4:20PM *Non-Uniform Mapping in Real-Coded Genetic Algorithms [#E-14796]*

Yashesh Dhebar, Kalyanmoy Deb and Sunith Bandaru,
Indian Institute of Technology - Kanpur, India;
Mishigan State University, United States; University of Skovde, Sweden

Genetic algorithms have been used as optimization tool using evolutionary strategies. Genetic algorithms cover three basic steps for population refinement selection, cross-over and mutation. In normal Real-coded genetic algorithm(RGA), the population of real variables generated after population refinement operations, is used as it is for the computation of the objective function. In this paper we have shown the effect made by mapping the refined population towards better solutions and thereby creating more biased search. The mapping used was non-uniform in nature and was the function of the position of the individual w.r.t. the best solution obtained so far in the algorithm, and hence the name Non-Uniform RGA or in short NRGA. Tests were performed on standard benchmark problems. The results were promising and should encourage further research in this dimension.

4:40PM *Bandits Attack Function Optimization [#E-14687]*

Preux Philippe, Munos Remi and Valko Michal,
Universite de Lille 3, France; Inventeurs du monde numerique, France

We consider function optimization as a sequential decision making problem under the budget constraint. Such constraint limits the number of objective function evaluations allowed during the optimization. We consider an algorithm inspired by a continuous version of a multi-armed bandit problem which attacks this optimization problem by solving the tradeoff between exploration (initial quasi-uniform search of the domain) and exploitation (local optimization around the potentially global maxima). We introduce the so-called Simultaneous Optimistic Optimization (SOO), a deterministic algorithm that works by domain partitioning. The benefit of such an approach are the guarantees on the returned solution and the numerical efficiency of the algorithm. We present this machine learning rooted approach to optimization, and provide the empirical assessment of SOO on the CEC'2014 competition on single objective real-parameter numerical optimization test-suite.

5:00PM *Differential Evolution with Rotation-Invariant Mutation and Competing-Strategies Adaptation [#E-14808]*

Petr Bujok, Josef Tvrdik and Radka Polakova,
University of Ostrava, Czech Republic

A new variant of the adaptive differential evolution algorithm was proposed and tested experimentally on the CEC 2014 test suite. In the new variant, the adaptation is based on the competition of several strategies. A part of strategies in the pool uses the rotation-invariant current-to-pbest mutation in the novel algorithm. The aim of the experimental comparison was to find whether the presence of the rotation-invariant strategy is able to improve the efficiency of the differential evolution algorithm, especially in problems with rotated objective functions. The results of the experiments showed that the new variant performed well in a few of the test problems, while no apparent benefit was observed in the majority of the benchmark problems.

5:20PM *Partial Opposition-Based Adaptive Differential Evolution Algorithms: Evaluation on the CEC 2014 Benchmark Set for Real-Parameter Optimization [#E-14554]*

Zhongyi Hu, Yukun Bao and Tao Xiong, Huazhong University of Science and Technology, China

Opposition-based Learning (OBL) has been reported with an increased performance in enhancing various optimization approaches. Instead of investigating the opposite point of a candidate in OBL, this study proposed a partial opposition-based learning (POBL) schema that focuses a set of partial opposite points (or partial opposite population) of an estimate. Furthermore, a POBL-based adaptive differential evolution algorithm (POBL-ADE) is proposed to improve the effectiveness of ADE. The proposed algorithm is evaluated on the CEC2014's test suite in the special session and competition for real parameter single objective optimization in IEEE CEC 2014. Simulation results over the benchmark functions demonstrate the effectiveness and improvement of the POBL-ADE compared with ADE.

5:40PM *Memetic Differential Evolution Based on Fitness Euclidean-Distance Ratio [#E-14529]*

Jane Jing Liang, Boyang Qu, H. Song and Z. G. Shang, Zhengzhou University, China; Zhongyuan University of Technology, China

In this paper, a differential evolution algorithm based on fitness Euclidean-distance ratio which was proposed to maintain multiple peaks in the multimodal optimization problems was modified to solve the complex single objective real parameter optimization problems. With the fitness Euclidean-distance ratio technique, the diversity of the population was kept to enhance the exploration ability. And in order to improve the exploitation ability, the Quasi-Newton method was combined. The performance of the proposed method on the set of benchmark functions provided by CEC2014 competition on single objective real- parameter numerical optimization was reported.

ThE2-4 Music, Art, Creativity, Games and Multi-Agent Systems

Thursday, July 10, 4:00PM-6:00PM, Room: 203D, Chair: Francisco Fernández de Vega

4:00PM *A Self Organising Map Based Method for Understanding Features Associated with High Aesthetic Value Evolved Abstract Images [#E-14090]*

Allan Campbell, Vic Ciesielski and Karen Trist, RMIT University, Australia

We show a method that allows the pixel data of a set of images to be analyzed independently of any set of computed features. If the high and low aesthetic value images can be separated in the high dimensional space of pixel intensities then for any given set of features computed from the images, those features relevant to high aesthetic value can be determined and the range of feature values that correlate with high aesthetic appeal can be quantified. The method uses the Self Organizing Map to project raw pixel data of images onto a feature map. The aesthetic class of these images is overlayed on the feature map, yielding a semantic map. Average feature values are visualized in gray-scale heat maps and features relevant to aesthetic value are identified. We call this the Pixel Array Self Organizing Map (PASOM) method. For the set of images analyzed, brightness and texture features were identified as being discriminatory between images of high and low aesthetic value. High aesthetic value images tend to have higher brightness and richer textures. These findings were corroborated by a professional artist/photographer as being consistent with the principles for attaining aesthetic value in visual media. The PASOM method yields a semantic map and a visualization of feature value variation that together make possible a detailed analysis of features associated with the aesthetic value of images.

4:20PM *When Artists Met Evospace-i [#E-14396]*

Francisco Fernandez de Vega, Mario Garcia-Valdez, Lilian Navarro, Cayetano Cruz, Patricia Hernandez, Tania Gallego and J. Vicente Albarran, University of Extremadura, Spain; Instituto Tecnologico de Tijuana, Mexico; Escuela de Artes y Oficios de Merida, Spain; University of Seville, Spain

This paper presents a new step towards a hard goal: establishing a stronger collaboration between the art world and the field of Evolutionary Algorithms, so that both can benefit. Two were the main reasons for pursuing this goal: on the one hand the aim of studying human creative processes that may allow in the future improving computer based creativity; on the other hand we wanted to both improve available software tools and also propose a methodology allowing artists to develop collective evolutionary based artistic experiences. This paper focuses in the second goal, and shows a new addition to EvoSpace-i software tool, as well as to the methodology applied, and how it was employed by a team of artists when creating a new collective artwork.

4:40PM *Parallelization of Information Set Monte Carlo Tree Search [#E-14726]*

Nicholas Sephton, Peter Cowling, Edward Powley, Daniel Whitehouse and Nicholas Slaven, University of York, United Kingdom; Orange Helicopter Games, United Kingdom; Stainless Games, United Kingdom

Process parallelization is more important than ever, as most modern hardware contains multiple processors and advanced multi-threading capability. This paper presents an analysis of the parallel behaviour of Information Set Monte Carlo Tree Search and the Upper Confidence Bounds for Trees (UCT) variant of MCTS, and certain parallelization techniques (specifically Tree Parallelization) have different effects upon ISMCTS and Plain UCT. The paper presents a study of the relative effectiveness of different types of parallelization, including Root, Tree, Tree with Virtual Loss, and Leaf.

5:00PM *Comparing Crossover Operators in Neuro-Evolution with Crowd Simulations [#E-14540]*

Sunrise Wang, James Gain and Geoff Nitschke, University of Cape Town, South Africa

Crowd simulations are a set techniques used to control groups of agents and are exemplified by scenes from movies such as The Lord of the Rings and Inception. A problem which all crowd simulation techniques suffer from is the balance between control of the crowd behaviour and the autonomy of the agents. One possible solution to this problem is to use Neuro-Evolution(NE) to evolve the agent models so that the agents behave realistically and the emergent crowd behaviour is controllable. Since this is not an application area which has been investigated much, it is unknown which NE parameters and operators work well. This paper attempts to address this by comparing the performance of a set of crossover operators and with a range of probabilities across various crowd simulations. Overall it was found that Laplace crossover worked the best across all our simulations.

5:20PM *Genotype Coding, Diversity, and Dynamic Environments: A Study on an Evolutionary Neural Network Multi-Agent System [#E-14747]*

Jaime Davila, Hampshire College, United States

This paper reports the effects that different coding schemes at the genetic level have on the evolution of neural network multi-agent systems that operate under dynamic (changing) environments. Types of NN encoding include direct encoding of weights and three different L-Systems. Empirical results show that even variations within the same type of coding scheme can have considerable effects on evolution. Several different analysis of both genotypes and phenotypes are used in order to explain the differences caused by the coding schemes.

5:40PM *The 2013 Multi-Objective Physical Travelling Salesman Problem Competition [#E-14052]*
Diego Perez, Edward Powley, Daniel Whitehouse, Spyridon Samothrakis, Simon Lucas and Peter Cowling, University of Essex, United Kingdom; University of York, United Kingdom

This paper presents the game, framework, rules and results of the Multi-objective Physical Travelling Salesman Problem (MO-PTSP) Competition, that was held at the 2013 IEEE Conference on Computational Intelligence in Games (CIG). The MO-PTSP is a real-time game that can be seen as a modification of the Travelling Salesman Problem, where the player controls a ship that must visit a series of waypoints in a maze while minimizing three opposing goals: time spent, fuel consumed and damage taken. The rankings of the competition are computed using multi-objective concepts, a novel approach in the field of game artificial intelligence competitions. The winning entry of the contest is also explained in detail. This controller is based on the Monte Carlo Tree Search algorithm, and employed Covariance Matrix Adaptation Evolution Strategy (CMA-ES) for parameter tuning.

ThE2-5 Real-World Applications I

Thursday, July 10, 4:00PM-6:00PM, Room: 303, Chair: Maoguo Gong and Qing Cai

4:00PM *Vessel Track Correlation and Association Using Fuzzy Logic and Echo State Networks [#E-14025]*
Hang Shao, Rami Abielmona, Rafael Falcon and Nathalie Japkowicz, University of Ottawa, Canada; Larus Technologies, Canada

Tracking moving objects is a task of the utmost importance to the defence community. As this task requires high accuracy, rather than employing a single detector, it has become common to use multiple ones. In such cases, the tracks produced by these detectors need to be correlated (if they belong to the same sensing modality) or associated (if they were produced by different sensing modalities). In this work, we introduce Computational-Intelligence-based methods for correlating and associating various contacts and tracks pertaining to maritime vessels in an area of interest. Fuzzy k-Nearest Neighbours will be used to conduct track correlation and Fuzzy C-Means clustering will be applied for association. In that way, the uncertainty of the track correlation and association is handled through fuzzy logic. To better model the state of the moving target, the traditional Kalman Filter will be extended using an Echo State Network. Experimental results on five different types of sensing systems will be discussed to justify the choices made in the development of our approach. In particular, we will demonstrate the judiciousness of using Fuzzy k- Nearest Neighbours and Fuzzy C-Means on our tracking system and show how the extension of the traditional Kalman Filter by a recurrent neural network is superior to its extension by other methods.

4:20PM *Automatic Target Recognition Using Multiple-Aspect Sonar Images [#E-14095]*
Xiaoguang Wang, Xuan Liu, Nathalie Japkowicz and Stan Matwin, University of Ottawa, Canada; Dalhousie University, Canada

Automatic Target Recognition (ATR) methods have been successfully applied to detect possible objects or regions of interest in sonar imagery. It is anticipated that the additional information obtained from additional views of an object should improve the classification performance over single-aspect classification. In this paper the detection of mine-like objects (MLO) on the seabed from multiple side- scan sonar views is considered. We transform the multiple-aspect classification problem into a multiple-instance learning problem and present a framework based upon the concepts of multiple-instance classifiers. Moreover, we present another framework based upon the Dempster-Shafer (DS) concept of fusion from single-view classifiers. Our experimental results indicate that both the presented frameworks can be successfully used in mine-like object classification.

4:40PM *Base Station Switching Problem for Green Cellular Networks with Social Spider Algorithm [#E-14036]*
James J.Q. Yu and Victor O.K. Li, The University of Hong Kong, Hong Kong

With the recent explosion in mobile data, the energy consumption and carbon footprint of the mobile communications industry is rapidly increasing. It is critical to develop more energy-efficient systems in order to reduce the potential harmful effects to the environment. One potential strategy is to switch off some of the under-utilized base stations during off-peak hours. In this paper, we propose a binary Social Spider Algorithm to give guidelines for selecting base stations to switch off. In our implementation, we use a penalty function to formulate the problem and manage to bypass the large number of constraints in the original optimization problem. We adopt several randomly generated cellular networks for simulation and the results indicate that our algorithm can generate superior performance.

5:00PM *Deployment Optimization of Near Space Airships Based on MOEA/D with Local Search [#E-14249]*
Zhao Wang, Maoguo Gong, Qing Cai, Lijia Ma and Licheng Jiao, Xidian University, China

The near space communication system is a burgeoning communication system. This system has many advantages over the satellite and terrestrial networks. Being built on the near space airships, the deployment of the airships has a significant impact on the performance of the system. Various factors should be taken into consideration to build such a system of which some objectives relate with each other and specific areas weight objectives differently. The evolutionary multiobjective optimization can fulfill the purpose to provide a series of choices of the deployment scheme. In this paper, a model of such a system is proposed and solved by the multiobjective evolutionary algorithm based on decomposition. Cases with different number of airships are tested and the Pareto Front is obtained. In order to increase the density of the Pareto Front, a local search method based on the positions of the airships is proposed. The experiment shows that the local search method can effectively increase the number of Pareto solutions obtained.

5:20PM *Novel Traffic Signal Timing Adjustment Strategy Based on Genetic Algorithm [#E-14150]*
Hsiao-Yu Tung, Wei-Chiu Ma and Tian-Li Yu, National Taiwan University, Taiwan

Traffic signal timing optimization problem aims at alleviating traffic congestion and shortening the average traffic time. However, most existing research considered only the information of one or few intersections at a time. Those local optimization methods may experience a decrease in performance when facing large- scale traffic networks. In this paper, we propose a cellular automaton traffic simulation system and conduct tests on two different optimization schemes. We use Genetic Algorithm (GA) for global optimization and Expectation Maximization (EM) as well as car flow for local optimization. Empirical results show that the GA method outperforms the EM method. Then, we use linear regression to learn from the global optimal solution obtained by GA and propose a new adjustment strategy that outperforms recent optimization methods.

5:40PM *Encodings for Evolutionary Algorithms in Smart Buildings with Energy Management Systems [#E-14827]*

Ingo Mauser, Marita Dorscheid, Florian Allerding and Hartmut Schmeck, FZI - Research Center for Information Technology, Germany; Karlsruhe Institute of Technology, Germany

In energy systems, the transition from traditional, centralized architecture and controllable generation to an ever more decentralized and volatile generation due to an increasing use of renewable energy sources arises new challenges for the management and balancing of the electricity grid. These can be met through energy management systems (EMS) that enable flexible consumption and production of energy on the demand side of the grid. The EMS for smart buildings that is used within this paper allows for the integration of a multitude of devices through an architectural approach which is similar to plug-and-play. These devices can then be optimized to a flexible load shape by an Evolutionary Algorithm (EA). The differentiated optimization capabilities of the devices require adequate encoding schemes. Such schemes are the major contribution of this paper. The aptitude of these encodings is shown and validated through the simulation of smart buildings with different configurations, both concerning quantitative and qualitative benefits to be achieved according to energy systems' transition and users' objectives.

Friday, July 11, 8:10AM-10:10AM

FrE1-1 Differential Evolution

Friday, July 11, 8:10AM-10:10AM, Room: 203A, Chair: Carlos Segura

8:10AM *Evolving Artificial Datasets to Improve Interpretable Classifiers [#E-14041]*

Michael Mayo and Quan Sun, University of Waikato, New Zealand

Differential Evolution can be used to construct effective and compact artificial training datasets for machine learning algorithms. In this paper, a series of comparative experiments are performed in which two simple and interpretable supervised classifiers (specifically, Naive Bayes and linear Support Vector Machines) are trained (i) directly on "real" data, as would be the normal case, and (ii) indirectly, using special artificial datasets derived from real data via evolutionary optimization. The results across several challenging test problems show that supervised classifiers trained indirectly using our novel evolution- based approach produce models with superior predictive classification performance. Besides presenting the accuracy of the learned models, we also analyze the sensitivity of our artificial data optimization process to Differential Evolution's parameters, and then we examine the statistical characteristics of the artificial data that is evolved.

8:30AM *Differential Evolution in Constrained Sampling Problems [#E-14207]*

Gervasio Varela, Pilar Caamano, Felix Orjales, Alvaro Deibe, Fernando Lopez-Pena and Richard Duro, Universidade da Coruna, Spain

This work proposes a set of modifications to the Differential Evolution algorithm in order to make it more efficient in solving a particular category of problems, the so called Constrained Sampling problems. In this type of problems, which are usually related to the on-line real-world application of evolution, it is not always straightforward to evaluate the fitness landscapes due to the computational cost it implies or to physical constraints of the specific application. The fact is that the sampling or evaluation of the offspring points within the fitness landscape generally requires a decoding phase that implies physical changes over the parents or elements used for sampling the landscape, whether through some type of physical migration from their locations or through changes in their configurations. Here we propose a series of modifications to the Differential Evolution algorithm in order to improve its efficiency when applied to this type of problems. The approach is compared to a standard DE using some common real-coded benchmark functions and then it is applied to a real constrained sampling problem through a series of real experiments where a set of Unmanned Aerials Vehicles is used to find shipwrecked people.

8:50AM *Unsupervised Clustering and Multi-Optima Evolutionary Search [#E-14436]*

Vassilis Plagianakos, University of Thessaly, Greece

This paper pursues a course of investigation of an approach to combine Evolutionary Computation and Data Mining for the location and computation of multiple local and global optima of an objective function. To accomplish this task we exploit the spatial concentration of the population members around the optima of the objective function. Such concentration regions are determined by applying clustering algorithms on the actual positions of the members of the population. Subsequently, the evolutionary search is confined in the interior of the regions discovered. To enable the simultaneous discovery of more than one global and local optima, we propose the use of clustering algorithms that also provide intuitive approximations for the number of clusters. Furthermore, the proposed scheme has often the potential of accelerating the convergence speed of the Evolutionary Algorithm, without the need for extra function evaluations.

9:10AM *A Novel Differential Evolution (DE) Algorithm for Multi-Objective Optimization [#E-14533]*

Xin Qiu, Jianxin Xu and Kay Chen Tan, National University of Singapore, Singapore

Convergence speed and parametric sensitivity are two issues that tend to be neglected when extending Differential Evolution (DE) for multi-objective optimization. To fill in this gap, we propose a multi-objective DE variant with an extraordinary mutation strategy and unfixed parameters. Wise tradeoff between convergence and diversity is achieved via the novel cross-generation mutation operators. In addition, a dynamic mechanism enables the parameters to evolve continuously during the optimization process. Empirical results show that the proposed algorithm is powerful in handling multi-objective problems.

9:30AM *Differential Evolution Algorithm Applied to Non-Stationary Bandit Problem [#E-14588]*

David L. St-Pierre and Jialin Liu, University of Liege, France; InstitutNational de Recherche en Informatique et en Automatique, France

In this paper we compare Differential Evolution (DE), an evolutionary algorithm, to classical bandit algorithms over non-stationary bandit problem. First we define a testcase where the variation of the distributions depends on the number of times an option is evaluated rather than over time. This definition allows the possibility to apply these algorithms over a wide range of problems such as black-box portfolio selection. Second we present our own variant of discounted Upper Confidence Bound (UCB) algorithm that outperforms the current state-of-the-art algorithms for non-stationary bandit problem. Third, we introduce a variant of DE and show that, on a selection

over a portfolio of solvers for the Cart-Pole problem, our version of DE outperforms the current best UCBs algorithms.

9:50AM *Effects of Population Initialization on Differential Evolution for Large Scale Optimization [#E-14804]*

Borhan Kazimipour, Xiaodong Li and A. K. Qin, RMIT University, Australia

This work provides an in-depth investigation of the effects of population initialization on Differential Evolution (DE) for dealing with large scale optimization problems. Firstly, we conduct a statistical parameter sensitive analysis to study the effects of DE's control parameters on its performance of solving large scale problems. This study reveals the optimal parameter configurations which can lead to the statistically superior performance over the CEC-2013 large-scale test problems. Thus identified optimal parameter configurations interestingly favour much larger population sizes while agreeing with the other parameter settings compared to the most commonly employed parameter configuration. Based on one of the identified optimal configurations and the most commonly used configuration, which only differ in the population size, we investigate the influence of various population initialization techniques on DE's performance. This study indicates that initialization plays a more crucial role in DE with a smaller population size. However, this observation might be the result of insufficient convergence due to the use of a large population size under the limited computational budget, which deserve more investigations.

FrE1-2 Process Mining and Data Mining

Friday, July 11, 8:10AM-10:10AM, Room: 203B, Chair: Andrea Burattin

8:10AM *Declarative Process Discovery with Evolutionary Computing [#E-14157]*

Seppe vanden Broucke, Jan Vanthienen and Bart Baesens, KU Leuven, Belgium

The field of process mining deals with the extraction of knowledge from event logs. One task within the area of process mining entails the discovery of process models to represent real-life behavior as observed in day-to-day business activities. A large number of such process discovery algorithms have been proposed during the course of the past decade, among which techniques to mine declarative process models (e.g. Declare and AGNEs Miner) as well as evolutionary based techniques (e.g. Genetic Miner and Process Tree Miner). In this paper, we present the initial results of a newly proposed evolutionary based process discovery algorithm which aims to discover declarative process models, hence combining these two classes (declarative and genetic) of discovery techniques. To do so, we herein use a language bias similar to the one found in AGNEs Miner to allow for the conversion from a set of declarative control-flow based constraints (determining the conditions which have to be satisfied to enable to execution of an activity) to a procedural process model, i.e. a Petri net, though this language bias can be extended to include data-based constraints as well.

8:30AM *Control-Flow Discovery from Event Streams [#E-14258]*

Andrea Burattin, Alessandro Sperduti and Wil M. P. van der Aalst, University of Padua, Italy; Eindhoven University of Technology, Netherlands

Process Mining represents an important research field that connects Business Process Modeling and Data Mining. One of the most prominent task of Process Mining is the discovery of a control-flow starting from event logs. This paper focuses on the important problem of control-flow discovery starting from a stream of event data. We propose to adapt Heuristics Miner, one of the most effective control-flow discovery algorithms, to the treatment of streams of event data. Two adaptations, based on Lossy Counting and Lossy Counting with Budget, as well as a sliding window based version of Heuristics Miner, are proposed and experimentally compared against both artificial and real streams. Experimental results show the effectiveness of control-flow discovery algorithms for streams on artificial and real datasets.

8:50AM *Perturbing Event Logs to Identify Cost Reduction Opportunities: A Genetic Algorithm-Based Approach [#E-14513]*

W.Z. Low, J. De Weerdt, M.T. Wynn, A.H.M. ter Hofstede, Wil M. P. van der Aalst and Seppe vanden Broucke, Queensland University of Technology, Australia; KU Leuven, Belgium; Technische Universiteit Eindhoven, Netherlands

Organisations are constantly seeking new ways to improve operational efficiencies. This research study investigates a novel way to identify potential efficiency gains in business operations by observing how they are carried out in the past and then exploring better ways of executing them by taking into account trade-offs between time, cost and resource utilisation. This paper demonstrates how they can be incorporated in the assessment of alternative process execution scenarios by making use of a cost environment. A genetic algorithm-based approach is proposed to explore and assess alternative process execution scenarios, where the objective function is represented by a comprehensive cost structure that captures different process dimensions. Experiments conducted with different variants of the genetic algorithm evaluate the approach's feasibility. The findings demonstrate that a genetic algorithm-based approach is able to make use of cost reduction as a way to identify improved execution scenarios in terms of reduced case durations and increased resource utilisation. The ultimate aim is to utilise cost-related insights gained from such improved scenarios to put forward recommendations for reducing process-related cost within organisations.

9:10AM *A Clustering-Based Approach for Exploring Sequences of Compiler Optimizations [#E-14831]*

Luiz Martins, Ricardo Nobre, Alexandre Delbem, Eduardo Marques and Joao Cardoso, Federal University of Uberlandia, Brazil; University of Porto/INESC-TEC, Portugal; University of Sao Paulo, Brazil

In this paper we present a clustering-based selection approach for reducing the number of compilation passes used in search space during the exploration of optimizations aiming at increasing the performance of a given function and/or code fragment. The basic idea is to identify similarities among functions and to use the passes previously explored each time a new function is being compiled. This subset of compiler optimizations is then used by a Design Space Exploration (DSE) process. The identification of similarities is obtained by a data mining method which is applied to a symbolic code representation that translates the main structures of the source code to a sequence of symbols based on transformation rules. Experiments were performed for evaluating the effectiveness of the proposed approach. The selection of compiler optimization sequences considering a set of 49 compilation passes and targeting a Xilinx MicroBlaze processor was performed aiming at latency improvements for 41 functions from Texas Instruments benchmarks. The results reveal that the passes selection based on our clustering method achieves a significant gain on execution time over the full search space still achieving important performance speedups.

9:30AM *A Study on Non-Correspondence in Spread between Objective Space and Design Variable Space for Trajectory Designing Optimization Problem [#E-14386]*

Toru Yoshida and Tomohiro Yoshikawa, Nagoya University, Japan

Recently, a lot of studies on Multi-Objective Genetic Algorithm (MOGA), in which Genetic Algorithm is applied to Multi-objective Optimization Problems (MOPs), have been reported actively.MOGA has been also applied to engineering design fields, then it is important not only to obtain Pareto solutions having high performance but also to analyze the obtained Pareto solutions and extract the knowledge in the designing problem.In order to analyze Pareto solutions obtained by MOGA, it is required to consider both the objective space and the design variable space. In this paper, we define"Non-Correspondence in Spread" between the objective space and the design variable space.We also try to extract Non-Correspondence area in Spread with the index defined in this paper.This paper applies the proposed method to the trajectory designing optimization problem and extracts Non-Correspondence area in Spread in the acquired Pareto solutions.

9:50AM *Ensemble Bayesian Model Averaging in Genetic Programming [#E-14702]*

Alexandros Agapitos, Michael O'Neill and Anthony Brabazon, University College Dublin, Ireland

This paper considers the general problem of function estimation via Genetic Programming (GP). Data analysts typically select a model from a population of models, and then proceed as if the selected model had generated the data. This approach ignores the uncertainty in model selection, leading to over-confident inferences and lack of generalisation. We adopt a coherent method for accounting for this uncertainty through a weighted averaging of all models competing in a population of GP. It is a principled statistical method for post-processing a population of programs into an ensemble, which is based on Bayesian Model Averaging (BMA). Under two different formulations of BMA, the predictive probability density function (PDF) of a response variable is a weighted average of PDFs centered around the individual predictions of component models that take the form of either standalone programs or ensembles of programs. The weights are equal to the posterior probabilities of the models generating the predictions, and reflect the models' skill on the training dataset. The method was applied to a number of synthetic symbolic regression problems, and results demonstrate that it generalises better than standard methods for model selection, as well as methods for ensemble construction in GP.

FrE1-3 Estimation of Distribution Algorithms and Machine Learning

Friday, July 11, 8:10AM-10:10AM, Room: 203C, Chair: Jose Antonio Lozano

8:10AM *Extending Distance-Based Ranking Models in Estimation of Distribution Algorithms [#E-14442]*

Josu Ceberio, Ekhine Irurozki, Alexander Mendiburu and Jose Antonio Lozano, University of the Basque Country UPV/EHU, Spain

Recently, probability models on rankings have been proposed in the field of estimation of distribution algorithms in order to solve permutation-based combinatorial optimisation problems. Particularly, distance-based ranking models, such as Mallows and Generalized Mallows under the Kendall's-tau distance, have demonstrated their validity when solving this type of problems. Nevertheless, there are still many trends that deserve further study. In this paper, we extend the use of distance-based ranking models in the framework of EDAs by introducing new distance metrics such as Cayley and Ulam. In order to analyse the performance of the Mallows and Generalized Mallows EDAs under the Kendall, Cayley and Ulam distances, we run them on a benchmark of 120 instances from four well known permutation problems. The conducted experiments showed that there is not just one metric that performs the best in all the problems. However, the statistical test pointed out that Mallows-Ulam EDA is the most stable algorithm among the studied proposals.

8:30AM *Quantum-Inspired Evolutionary Algorithm with Linkage Learning [#E-14403]*

Bo Wang, Hua Xu and Yuan Yuan, Tsinghua University, China

The quantum-inspired evolutionary algorithm (QEA) uses several quantum computing principles to optimize problems on a classical computer. QEA possesses a number of quantum individuals, which are all probability vectors. They work well for linear problems but fail on problems with strong interactions among variables. Moreover, many optimization problems have multiple global optima. And because of the genetic drift, these problems are difficult for evolutionary algorithms to find all global optima. Local and global migration that QEA uses to synchronize different individuals prevent QEA from finding multiple optima. To overcome these difficulties, we proposed a quantum-inspired evolutionary algorithm with linkage learning (QEALL). QEALL uses a modified concept-guide operator based on low order statistics to learn linkage. We also replaced the migration procedure by a niching technology to prevent genetic drift, accordingly to find all global optima and to expedite convergence speed. The performance of QEALL was tested on a number of benchmarks including both unimodal and multimodal problems. Empirical evaluation suggests that the proposed algorithm is effective and efficient.

8:50AM *Investigation on Efficiency of Optimal Mixing on Various Linkage Sets [#E-14124]*

Shih-Ming Wang, Yu-Fan Tung and Tian-Li Yu, National Taiwan University, Taiwan

The optimal mixing operator (OM) utilizes linkage sets (LSs) to exchange the information of variables between a pair of solutions, and the result of such exchange is adopted only if the exchange leads to improvement of the solution quality. The performance of OM highly depends on the LS it uses. This paper demonstrates that previously proposed LS, the linkage tree model (LT), does not yield the optimal performance. To measure the efficiency of OM on different LSs, the cost-performance (CP) index is defined. Both our CP index and experiments indicate (1) that for fully separable problems, the most suitable LS is the marginal product model (MP), and (2) that for separable problems with overlap, LT is more suitable than MP, and (3) that properly pruned LT leads to higher efficiency and yields a better performance, and (4) that the LS that properly reflects the problem structure yields the best performance on both fully separable problems and problems with overlap.

9:10AM *A Locally Weighted Metamodel for Pre-Selection in Evolutionary Optimization [#E-14399]*

Qiuxiao Liao, Aimin Zhou and Guixu Zhang, East China Normal University, China

The evolutionary algorithms are usually criticized for their slow convergence. To address this weakness, a variety of strategies have been proposed. Among them, the metamodel or surrogate based approaches are promising since they replace the original optimization objective by a metamodel. However, the metamodel building itself is expensive and therefore the metamodel based evolutionary algorithms are commonly applied to expensive optimization. In this paper, we propose an alternative metamodel, named locally weighted metamodel (LWM), for the pre-selection in evolutionary optimization. The basic idea is to estimate the objective values of candidate offspring solutions for an individual, and choose the most promising one as the offspring solution. Instead of building a global model as many other algorithms do, a LWM is built for each candidate offspring solution in our approach. The LWM based pre-selection is implemented in a multi-operator based evolutionary algorithm, and applied to a set of test instances with different characteristics. Experimental results show that the proposed approach is promising.

9:30AM *Use Model Building on Discretization Algorithms for Discrete EDAs to Work on Real-Valued Problems [#E-14142]*

Yi-En Su and Tian-Li Yu, National Taiwan University, Taiwan

Discretization algorithms have been combined with discrete estimation of distribution algorithms (EDAs) to work on real-valued problems. Existing discretization algorithms, such as the fixed-height histogram (FHH) and the split-on-demand (SoD), utilize merely densities of selected chromosomes to build next- generation population, and therefore have limited exploration. This paper adds the concept of model building to FHH and SoD to solve these problems. The model utilizes a variety of information from selected chromosomes to improve the abilities of FHH and SoD to identify promising regions for future exploration. Specifically, a model of expected values of selected chromosomes is combined with FHH and SoD to form expected-value FHH and expected-value SoD. The expected-value-discretization algorithms outperform their original versions on an exploration test function as well as the 25 benchmark functions used in the SoD paper. This paper also introduces a model of differential-expected-value of selected chromosomes. The differential-expected-value FHH and differential-expected-value SoD outperform their expected-value versions when tested on the exploration test function and the 25 benchmark functions.

9:50AM *Transformation of Input Space Using Statistical Moments: EA-Based Approach [#E-14364]*

Ahmed Kattan, Michael Kampouridis, Yew-Soon Ong and Khalid Mehamdi, Um Al Qura University, Saudi Arabia; University of Kent, United Kingdom; Nanyang Technological University, Singapore

Reliable regression models in the field of Machine Learning (ML) revolve around the fundamental property of generalisation. This ensures that the induced model is a concise approximation of a data-generating process and performs correctly when presented with data that have not been utilised during the learning process. Normally, the regression model is presented with n samples from an input space; that is composed of observational data of the form (xi, y(xi)), i = 1...n where each xi denotes a k dimensional input vector of design variables and y is the response. When k n, high variance and over-fitting become a major concern. In this paper we propose a novel approach to mitigate this problem by transforming the input vectors into new smaller vectors (called Z set) using only a set of simple statistical moments. Genetic Algorithm (GA) has been used to evolve a transformation procedure. It is used to optimise an optimal sequence of statistical moments and their input parameters. We used Linear Regression (LR) as an example to quantify the quality of the evolved transformation procedure. Empirical evidences, collected from benchmark functions and real-world problems, demonstrate that the proposed transformation approach is able to dramatically improve LR generalisation and make it outperform other state of the art regression models such as Genetic Programming, Kriging, and Radial Basis Functions Networks. In addition, we present an analysis to shed light on the most important statistical moments that are useful for the transformation process.

FrE1-4 Evolutionary Computation Theory and Parameter Optimization

Friday, July 11, 8:10AM-10:10AM, Room: 203D, Chair: Yaochu Jin

8:10AM *A Progressive Random Walk Algorithm for Sampling Continuous Fitness Landscapes [#E-14716]*

Katherine Malan and Andries Engelbrecht, University of Pretoria, South Africa

A number of fitness landscape analysis approaches are based on random walks through discrete search spaces. Applying these approaches to real-encoded problems requires the notion of a random walk in continuous space. This paper proposes a progressive random walk algorithm and the use of multiple walks to sample neighbourhood structure in continuous multi-dimensional spaces. It is shown that better coverage of a search space is provided by progressive random walks than simple unbiased random walks.

8:30AM *Runtime Analysis of Selection Hyper-Heuristics with Classical Learning Mechanisms [#E-14762]*

Fawaz Alanazi and Per Kristian Lehre, The University of Nottingham, United Kingdom

The term selection hyper-heuristics refers to a randomised search technique used to solve computational problems by choosing and executing heuristics from a set of pre-defined low-level heuristic components. Selection hyper-heuristics have been successfully employed in many problem domains. Nevertheless, a theoretical foundation of these heuristics is largely missing. Gaining insight into the behaviour of selection hyper-heuristics is challenging due to the complexity and random design of these heuristics. This paper is one of the initial studies to analyse rigorously the runtime of selection hyper-heuristics with a number of the most commonly used learning mechanisms; namely, simple random, random gradient, greedy, and permutation. We derive the runtime of selection hyper- heuristic with these learning mechanisms not only on a classical example problem, but also on a general model of fitness landscapes. This in turn helps in understanding the behaviour of hyper-heuristics. Our results show that all the considered selections hyper-heuristics have roughly the same performance. This suggests that the learning mechanisms do not necessarily improve the performance of hyper-heuristics. A new learning mechanism that improves the performance of hyper-heuristic on our example problem is presented.

8:50AM *Particle Swarm Convergence: An Empirical Investigation [#E-14451]*

Christopher Cleghorn and Andries Engelbrecht, University of Pretoria, South Africa

This paper performs a thorough empirical investigation of the conditions placed on particle swarm optimization control parameters to ensure convergent behavior. At present there exists a large number of theoretically derived parameter regions that will ensure particle convergence, however, selecting which region to utilize in practice is not obvious. The empirical study is carried out over a region slightly larger than that needed to contain all the relevant theoretically derived regions. It was found that there is a very strong correlation between one of the theoretically derived regions and the empirical evidence. It was also found that parameters near the edge of the theoretically derived region converge at a very slow rate, after an initial population explosion. Particle convergence is so slow, that in practice, the edge parameter settings should not really be considered useful as convergent parameter settings.

9:10AM *Phase Transition Particle Swarm Optimization [#E-14434]*

Ji Ma, Junqi Zhang, Wei Wang and Jing Yao, Tongji University, China

In nature, a phase transition is the transformation of a thermodynamic system from one phase to another. Different phases of a thermodynamic system have distinctive physical properties. Inspired by this natural phenomenon, this paper presents a Particle Swarm Optimization (PSO) based on the Phase Transitions model which consists of solid, liquid and gas phases. Each phase represents a distinctive behavior of the swarm. Transitions of condensation, solidification and deposition can enhance the exploitation capability of the swarm. While the transitions of fusion, vaporization and sublimation from the other direction improve the exploration capability of the swarm. The proposed model directs the swarm to transform among phases dynamically and automatically according to the evolutional states to balance between exploration and exploitation adaptively. Especially, it uses a new modified PSO algorithm called Simple Fast Particle Swarm Optimization (SFPSO) in the solid phase, which modifies the original PSO by adding new parameters simply to make the algorithm convergence more quickly. The proposed algorithm is validated by extensive simulations on the 28 real-parameter optimization benchmark functions from CEC 2013 compared with other three representative variants of PSO.

9:30AM *Fitness Level Based Adaptive Operator Selection for Cutting Stock Problems with Contiguity [#E-14250]*

Kai Zhang, Thomas Weise and Jinlong Li, University of Science and Technology of China, China

For most optimization problem and solution representation, multiple different possible search operators exist. In this article, we propose the Fitness Level based Adaptive Operator Selection (FLAOS), a self-adaptation approach that automatically selects the right operator depending on the progress of the search. In FLAOS, the objective values of the solutions discovered during the optimization process are divided into intervals, the fitness levels. For each fitness level, a corresponding probability distribution is maintained which defines which operators are to be used and how often to generate the offsprings. An evolutionary algorithm with FLAOS is proposed to solve one-dimensional cutting stock problems (CSPs) with contiguity. The solution of such a problem should minimize both the trim loss and the number of partially finished items. Experimental studies have been carried out to test the effectiveness of the FLAOS. The solutions found by FLAOS are better than or comparable to those solutions found by previous methods.

9:50AM *Parameter Optimization by Means of Statistical Quality Guides in F-Race [#E-14465]*

Ronald Klazar and Andries Engelbrecht, University of Pretoria, South Africa

F-Race and its variant, Iterated F-Race, is an automated procedure for sampling and evaluating potential values of parameters for algorithms. The procedure is controlled by means of a computational budget that limits the number of evaluations that may be conducted, thus forcing the determination of the best possible configuration to be made within a limited time. When time is not severely constrained, the a priori choice of a computational budget becomes unjustifiable because the relationship between the computational budget and the quality of the optimization of a black box subject is not obvious. This paper proposes an extension to F-Race in the form of a heuristic method for reasonably terminating the optimization procedure.

FrE1-5 Multimodal Optimization and Population Initialization

Friday, July 11, 8:10AM-10:10AM, Room: 303, Chair: Jonathan Fieldsend

8:10AM *A Globally Diversified Island Model PGA for Multimodal Optimization [#E-14641]*

Lifeng Zhang and Rong He, Renmin University of China, China

Multimodal optimization aims to find multiple global and local optima as opposed to only the best optimum. Parallel genetic algorithms (PGAs) provide a natural advantage for dealing with this issue, since they are multi-population based searching methodologies. For single population based evolutionary algorithms, a number of niching and multimodal optimization techniques have been proposed and successfully applied to cope with this problem. However, these approaches are definitely not applicable for PGAs, since due to communicational and computational costs it is very always impossible to obtain and compute global information of all the sub-populations during massive parallel evolution procedure. In this study, a new island model PGA, called local competition model (LCM), is developed to cope with this issue. The new method only uses local information received from a few neighbouring subpopulations to reach a global diversification in which all the subpopulations are automatically allocated to different areas of searching space so that they can converge to multiple optima including both global optima and local optima. Finally, experimental studies on both real number optimization and combinatorial optimization are implemented to illustrate the performance of the new PGA model.

8:30AM *A Topological Niching Covariance Matrix Adaptation for Multimodal Optimization [#E-14679]*

Marcio Pereira, Mauro Roisenberg and Guenther Neto, UFSC, Brazil; PETROBRAS S/A, Brazil

Multimodal optimization attempts to find multiple global and local optima of a function. Finding a set of optimal solutions is particularly important for practical problems. However, this kind of problem requires optimization techniques that demand a high computational cost and a large amount of parameters to be adjusted. These difficulties increase in high-dimensional space problems. In this work, we propose a niching method based on recent developments in the basins (optimal locations) identification to reduce costs and perform better in high-dimensional spaces. Using Nearest-Better Clustering (NBC) and Hill-Valley (or Detect Multimodal) methods, an exploratory initialization routine is employed to identify basins on functions with different levels of complexity. To maintain diversity over the generations, we define a bi-objective function, which is composed by the original fitness function and the distance to the nearest better neighbor, assisted by a reinitialization scheme. The proposed method is implemented using Evolutionary Strategy (ES) known as Covariance Matrix Adaptation (CMA). Unlike recent multimodal approaches using CMA-ES, we use its step size to control the influence of niche, thus avoiding extra efforts in parameterization. We apply a benchmark of 20 test functions, specially designed for multimodal optimization evaluation, and compare the performance with a state-of-the-art method. Finally we discuss the results and show that the proposed approach can reach better and stable results even in high-dimensional spaces.

8:50AM *Balancing the Exploration and Exploitation in an Adaptive Diversity Guided Genetic Algorithm [#E-14087]*

Fatemeh Vafaee, Gyorgy Turan, Peter Nelson and Tanya Berger-Wolf, University of Sydney, Australia; University of Illinois at Chicago, United States

Exploration and exploitation are the two cornerstones which characterize Evolutionary Algorithms (EAs) capabilities. Maintaining the reciprocal balance of the explorative and exploitative power is the key to the success of EA applications. Accordingly, this work is concerned with proposing a diversity-guided genetic algorithm with a new mutation scheme that is capable of exploring the unseen regions of the search space, as well as exploiting the already-found promising elements. The proposed mutation operator specifies different mutation rates for different sites of an encoded solution. These site-specific rates are carefully derived based on the underlying pattern of highly-fit solutions, adjusted to every single individual, and adapted throughout the evolution to retain a good ratio between exploration and exploitation. Furthermore, in order to more directly monitor the exploration vs. exploitation balance, the proposed method is augmented with a diversity control process assuring that the search process does not lose the required balance between the two forces.

9:10AM *Compensate Information from Multimodal Dynamic Landscapes: An Anti-Pathology Cooperative Coevolutionary Algorithm [#E-14602]*

Xingguang Peng, Xiaokang Lei and Kun Liu, Northwestern Polytechnical University, China

Cooperative coevolutionary algorithms (CCEAs) divides a problem into several components and optimizes them independently. Some coevolutionary information will be lost due to the search space separation. This may lead some algorithmic pathologies, such as relative overgeneralization. In addition, according to the interactive nature of the CCEA, the coevolutionary landscapes are dynamic. In this paper, a multi-population strategy is proposed to simultaneously search local or global optima in each dynamic landscape and provide them to the other components. Besides, a grid-based archive scheme is proposed to archive these historic collaborators for reasonable fitness evaluation. Two benchmark problems were used to test and compare the proposed algorithm to three classical CCEAs. Experimental results show that the proposed algorithm effectively counteract relative overgeneralization pathology and significantly improve the rate of converging to global optimum.

9:30AM *A Review of Population Initialization Techniques for Evolutionary Algorithms [#E-14789]*

Borhan Kazimipour, Xiaodong Li and A. K. Qin, RMIT University, Australia

Although various population initialization techniques have been employed in evolutionary algorithms (EAs), there lacks a comprehensive survey on this research topic. To fill this gap and attract more attentions from EA researchers to this crucial yet less explored area, we conduct a systematic review of the existing population initialization techniques. Specifically, we categorize initialization techniques from three exclusive perspectives, i.e., randomness, compositionality and generality. Characteristics of the techniques belonging to each category are carefully analysed to further lead to several sub-categories. We also discuss several open issues related to this research topic, which demands further in-depth investigations.

9:50AM *Running Up Those Hills: Multi-Modal Search with the Niching Migratory Multi-Swarm Optimiser [#E-14197]*

Jonathan Fieldsend, University of Exeter, United Kingdom

We present a new multi-modal evolutionary optimiser, the niching migratory multi-swarm optimiser (NMMSO), which dynamically manages many particle swarms. These sub-swarms are concerned with optimising separate local modes, and employ measures to allow swarm elements to migrate away from their parent swarm if they are identified as being in the vicinity of a separate peak, and to merge swarms together if they are identified as being concerned with the same peak. We employ coarse peak identification to facilitate the mode identification required. Swarm members are not constrained to particular subregions of the parameter space, however members are initialised in the vicinity of a swarm's local mode estimate. NMMSO is shown to cope with a range of problem types, and to produce results competitive with the state-of-the-art on the CEC 2013 multi-modal optimisation competition test problems, providing new benchmark results in the field.

Friday, July 11, 10:30AM-12:30PM

FrE2-1 Multi-Objective Evolutionary Algorithms III

Friday, July 11, 10:30AM-12:30PM, Room: 203A, Chair: Slawomir Wesolkowski

10:30AM *Multi-Scenario Optimization Using Multi-Criterion Methods: A Case Study on Byzantine Agreement Problem [#E-14837]*

Ling Zhu, Kalyanmoy Deb and Sandeep Kulkarni, Michigan State University, United States

In this paper, we address solution methodologies of an optimization problem under multiple scenarios. Often in practice, a problem needs to be considered for different scenarios, such as evaluating for different loading conditions, different blocks of data, multi-stage operations, etc. After reviewing various single-objective aggregate methods for handling objectives and constraints under multiple scenarios, we then suggest a multi-objective optimization approach for solving multi-scenario optimization problems. On a Byzantine agreement problem, we demonstrate the usefulness of the proposed multi-objective approach and explain the reasons for their superior behavior. The suggested procedure is generic and now awaits further applications to more challenging problems from engineering and computational fields.

10:50AM *Multi-Objective Evolutionary Recurrent Neural Network Ensemble for Prediction of Computational Fluid Dynamic Simulations [#E-14677]*

Christopher Smith, John Doherty and Yaochu Jin, University of Surrey, United Kingdom

Using a surrogate model to evaluate the expensive fitness of candidate solutions in an evolutionary algorithm can significantly reduce the overall computational cost of optimization tasks. In this paper we present a recurrent neural network ensemble that is used as a surrogate for the long-term prediction of computational fluid dynamic simulations. A hybrid multi-objective evolutionary algorithm that trains and optimizes the structure of the recurrent neural networks is introduced. Selection and combination of individual prediction models in the Pareto set of solutions is used to create the ensemble of predictors. Five selection methods are tested on six data sets and the accuracy of the ensembles is compared to the converged computational fluid dynamic data, as well as to the delta change between two flow conditions. Intermediate computational fluid dynamic data is used for training and the method presented can produce accurate and stable results using a third of the intermediate data needed for convergence.

11:10AM *TraDE: Training Device Selection Via Multi-Objective Optimization [#E-14700]*

Slawomir Wesolkowski, Nevena Francetic and Stuart Grant, Defence Research and Development Canada, Canada

Training planning is a recurring military problem. Since training programs can utilize multiple training devices with varying costs and training capabilities, selecting the types of devices required is a complex trade-off problem. Furthermore, the placement of these devices is critical due to the time and costs involved in travelling to and from the location of a training device. In this paper, we introduce a device bin-packing-and-location-based model, Training Device Estimation (TraDE), to study the computation of heterogeneous device mixes including the location of each device with respect to numerous objectives including various costs and training time. We apply the multi-objective Non-dominating Sorting Genetic Algorithm II to the TraDE model on a population represented by two-dimensional chromosomes. Finally, we also present a new mutation type to handle the nonlinearity inherent in a dual optimization problem which includes scheduling and location optimization. We clearly show that the new mutation operator produces superior results to the standard mutation operator.

11:30AM *Multi-view Clustering of Web Documents Using Multi-Objective Genetic Algorithm [#E-14735]*

Wahid Abdul, Xiaoying Gao and Andreae Peter, Victoria University of Wellington, New Zealand

Clustering ensembles are a common approach to clustering problem, which combine a collection of clustering into a superior solution. The key issues are how to generate different candidate solutions and how to combine them. Common approach for generating candidate clustering solutions ignores the multiple representations of the data (i.e., multiple views) and the standard approach of simply selecting the best solution from candidate clustering

solutions ignores the fact that there may be a set of clusters from different candidate clustering solutions which can form a better clustering solution. This paper presents a new clustering method that exploits multiple views to generate different clustering solutions and then selects a combination of clusters to form a final clustering solution. Our method is based on Non dominated Sorting Genetic Algorithm (NSGA-II), which is a multi-objective optimization approach. Our new method is compared with five existing algorithms on three data sets that have increasing difficulty. The results show that our method significantly outperforms other methods.

11:50AM *Visual Examination of the Behavior of EMO Algorithms for Many-Objective Optimization with Many Decision Variables [#E-14843]*

Hiroyuki Masuda, Yusuke Nojima and Hisao Ishibuchi, Osaka Prefecture University, Japan

Various evolutionary multiobjective optimization (EMO) algorithms have been proposed in the literature. They have different search mechanisms for increasing the diversity of solutions and improving the convergence to the Pareto front. As a result, each algorithm has different characteristics in its search behavior. Multiobjective search behavior can be visually shown in an objective space for a test problem with two or three objectives. However, such a visual examination is difficult in a high-dimensional objective space for many-objective problems. The use of distance minimization problems has been proposed to examine many-objective search behavior in a two-dimensional decision space. This idea has an inherent limitation: the number of decision variables should be two. In our former study, we formulated a four-objective distance minimization problem with 10, 100, and 1000 decision variables. In this paper, we generalize our former study to many-objective problems with an arbitrarily number of objectives and decision variables by proposing an idea of specifying reference points on a plane in a high-dimensional decision space. As test problems for computational experiments, we generate six-objective and eight-objective problems with 10, 100, and 1000 decision variables. Our experimental results on those test problems show that the number of decision variables has large effects on multiobjective search in comparison with the choice of an EMO algorithm and the number of objectives.

12:10PM *Sensitivity Analysis of Parallel Cell Coordinate System in Many-Objective Particle Swarm Optimization [#E-14452]*

Wang Hu, Gary Yen and Xin Zhang, University of Electronic Science and Technology of China, China; Oklahoma State University, United States

Parallel Cell Coordinate System (PCCS) was proposed to evaluate the individual fitness in an archive and access the population progress in the evolutionary environment. In a Many-objective Optimization Problem (MaOP), it is much harder to tradeoff the convergence and diversity than in a Multiobjective Optimization Problem. To more effectively tackle the MaOPs, the PCCS and the aggregation- based approach are integrated into a Many-objective Optimization Particle Swarm Optimization (MaOPSO). In this paper, the sensitivity of PCCS is examined with respect to the number of objectives and the maximum size of an archive. The experimental results indicate that the MaOPSO performs better than MOEA/D in terms of IGD and HV metrics on the WFG test suit, and PCCS is not sensitive to the number of objectives and the maximum size of an archive.

FrE2-2 Numerical Optimization

Friday, July 11, 10:30AM-12:30PM, Room: 203B, Chair: Joao M. Sousa

10:30AM *Real-Parameter Optimization with OptBees [#E-14671]*

Renato Maia, Leandro de Castro and Walmir Caminhas, State University of Montes Claros, Brazil; Mackenzie University, Brazil; Federal University of Minas Gerais, Brazil

This paper reports how OptBees, an algorithm inspired by the collective decision-making of bee colonies, performed in the test bed developed for the Special Session and Competition on Real-Parameter Single Objective (Expensive) Optimization at CEC-2014. The test bed includes 30 scalable functions, many of which are both non-separable and highly multi-modal. Results include OptBees' performance on the 10, 30, 50 and 100-dimensional versions of each function.

10:50AM *A Levy Flight-Based Hybrid Artificial Bee Colony Algorithm for Solving Numerical Optimization Problems [#E-14583]*

Hai Shan, Toshiyuki Yasuda and Kazuhiro Ohkura, Hiroshima University, Japan

An artificial bee colony (ABC) algorithm is one of numerous swarm intelligence algorithms that employs the foraging behavior of honeybee colonies. To improve the convergence performance and search speed of finding the best solution using this approach, we propose a levy flight-based hybrid ABC algorithm in this paper. To evaluate the performance of the standard and proposed ABC algorithms, we implemented numerical optimization problems based on the IEEE Congress on Evolutionary Computation 2013 test suite. The proposed ABC algorithm demonstrated competitive performance on these optimization problems as compared to standard ABC, differential evolution, and particle swarm optimization algorithms with dimension sizes of 10, 30, and 50, respectively.

11:10AM *Comparison of Random Number Generators in Particle Swarm Opimization Algorithm [#E-14500]*

Ke Ding and Ying Tan, Peking University, China

Intelligent optimization algorithms are very effective to tackle complex problems that would be difficult or impossible to solve exactly. A key component within these algorithms is the random number generators (RNGs) which provide random numbers to drive the stochastic search process. Much effort is devoted to develop efficient RNGs with good statistical properties, and many highly optimized libraries are ready to use for generating random numbers fast on both CPUs and other hardware platforms such as GPUs. However, few study is focused on how different RNGs can effect the performance of specific intelligent optimization algorithms. In this paper, we empirically compared 13 widely used RNGs with uniform distribution based on both CPUs and GPUs, with respect to algorithm efficiency as well as their impact on Particle Swarm Optimization (PSO). Two strategies were adopted to conduct comparison among multiple RNGs for multiple objectives. The experiments were conducted on well-known benchmark functions of diverse landscapes, and were run on the GPU for the purpose of accelerating. The results show that RNGs have very different efficiencies in terms of speed, and GPU-based RNGs can be much faster than their CPU-based counterparts if properly utilized. However, no statistically significant disparity in solution quality was observed. Thus it is reasonable to use more efficient RNGs such as Mersenne Twister. The framework proposed in this work can be easily extended to compare the impact of non-uniformly distributed RNGs on more other intelligent optimization algorithms.

11:30AM *A Evolutionary Algorithm Based on Covariance Matrix Leaning and Searching Preference for Solving CEC 2014 Benchmark Problems [#E-14751]*

Lei Chen, Hai-Lin Liu, Zhe Zheng and Shengli Xie, Guangdong University of Technology, China

In this paper, we propose a single objective op- timization evolutionary algorithm (EA) based on Covariance Matrix Learning and Searching Preference (CMLSP) and design a switching method which is used to

combine CMLSP and Covariance Matrix Adaptation Evolution Strategy (CMAES). Then we investigate the performance of the switch method on a set of 30 noiseless optimization problems designed for the special session on real-parameter optimization of CEC 2014. The basic idea of the proposed CMLSP is that it is more likely to find a better individual around a good individual. That is to say, the better an individual is, the more resources should be invested to search the region around the individual. To achieve it, we discard the traditional crossover and mutation and design a novel method based on the covariance matrix leaning to generate high quality solutions. The best individual found so far is used as the mean of a Gaussian distribution and the covariance of the best individuals in the population are used as the evaluation of its covariance matrix and we sample the next generation individual from the Gaussian distribution other than using crossover and mutation. In the process of generating new individuals, the best individual is changed if ever a better one is found. This search strategy emphasizes the region around the best individual so that a faster convergence can be achieved. The use of switch method is to make best use of the proposed CMLSP and existing CMAES. At last, we report the results.

11:50AM *Optimization of Power Flow with Energy Storage Using Genetic Algorithms [#E-14648]*

Vitor Leite, Carlos Silva, Joao Claro and Joao M. Sousa, Universidade de Lisboa, Portugal; Universidade do Porto, Portugal

This paper applies genetic algorithms to optimize the operation of a transmission network with energy storage capabilities, to optimize its costs, which include both generation and storage costs, for cases when the data inherent to the system is assumed to be perfectly known. The problem is formulated through the DC optimal power flow equations, including losses across the transmission lines, therefore allowing solutions regarding the network generation costs to be obtained, with and without storage. In this way, the financial impact inherent to the usage of energy storage can be derived. Since we are dealing with a large combinatorial problem, the search throughout the solution space was done by means of the Genetic Algorithms. The solutions consist of the storage device's charging or discharging rate at which it must be operating during each sub-interval considered for the simulations. The results delivered by the GA have proven the profitability of including energy storage capabilities in the transmission network of Sao Miguel (Portugal) and the usefulness of such algorithm in a real world application.

12:10PM *A New Self-Learning TLBO Algorithm for RBF Neural Modelling of Batteries in Electric Vehicles [#E-14432]*

Zhile Yang, Kang Li, Aoife Foley and Cheng Zhang, Queen's University Belfast, United Kingdom

One of the main purposes of building a battery model is for monitoring and control during battery charging/discharging as well as for estimating key factors of batteries such as the state of charge for electric vehicles. However, the model based on the electrochemical reactions within the batteries is highly complex and difficult to compute using conventional approaches. Radial basis function (RBF) neural networks have been widely used to model complex systems for estimation and control purpose, while the optimization of both the linear and non-linear parameters in the RBF model remains a key issue. A recently proposed meta-heuristic algorithm named Teaching Learning-Based Optimization (TLBO) is free of presetting algorithm parameters and performs well in non- linear optimization. In this paper, a novel self-learning TLBO based RBF model is proposed for modelling electric vehicle batteries using RBF neural networks. The modelling approach has been applied to two battery testing data sets and compared with some other RBF based battery models, the training and validation results confirm the efficacy of the proposed method.

FrE2-3 Coevolution and Collective Behavior

Friday, July 11, 10:30AM-12:30PM, Room: 203C, Chair: Grant Dick

10:30AM *Codynamic Fitness Landscapes of Coevolutionary Minimal Substrates [#E-14118]*

Hendrik Richter, HTWK Leipzig University of Applied Sciences, Germany

Coevolutionary minimal substrates are simple and abstract models that allow studying the relationships and codynamics between objective and subjective fitness. Using these models an approach is presented for defining and analyzing fitness landscapes of coevolutionary problems. We devise similarity measures of codynamic fitness landscapes and experimentally study minimal substrates of test--based and compositional problems for both cooperative and competitive interaction.

10:50AM *Model Representation and Cooperative Coevolution for Finite-State Machine Evolution [#E-14802]*

Grant Dick and Xin Yao, University of Otago, New Zealand; University of Birmingham, United Kingdom

The use and search of finite-state machine (FSM) representations has a long history in evolutionary computation. The flexibility of Mealy-style and Moore-style FSMs is traded against the large number of parameters required to encode machines with many states and/or large output alphabets. Recent work using Mealy FSMs on the Tartarus problem has shown good performance of the resulting machines, but the evolutionary search is slower than for other representations. The aim of this paper is two-fold: first, a comparison between Mealy and Moore representations is considered on two problems, and then the impact of cooperative coevolution on FSM evolutionary search is examined. The results suggest that the search space of Moore-style FSMs may be easier to explore through evolutionary search than the search space of an equivalent-sized Mealy FSM representation. The results presented also suggest that the tested cooperative coevolutionary algorithms struggle to appropriately manage the non-separability present in FSMs, indicating that new approaches to cooperative coevolution may be needed to explore FSMs and similar graphical structures.

11:10AM *Evolutionary Path Planning of a Data Mule in Wireless Sensor Network by Using Shortcuts [#E-14600]*

Shao-You Wu and Jing-Sin Liu, Institute of Information Science, Academia Sinica, Taiwan

Data collection problem of generating a path for a data mule (single or multiple mobile robots) to collect data from wireless sensor network (WSN) is usually a NP- hard problem. Thus, we formulate it as a Traveling Salesman Problem with Neighborhoods (TSPN) to obtain the possibly short path. TSPN is composed of determinations of the order of visiting sites and their precise locations. By taking advantage of the overlap of neighborhoods, we proposed a clustering-based genetic algorithm (CBGA) with an innovative way for initial population generation, called Balanced Standard Deviation Algorithm (BSDA). Then, effective shortcut schemes named Look-Ahead Locating Algorithm (LLA) and Advanced-LLA are applied on the TSPN route. By LLA, a smoother route is generated and the data mule can move while ignoring about 39% clusters. Extensive simulations are performed to evaluate the TSPN route in some aspects like LLA hits, LLA improvement, Rotation Degree of Data Mule (RDDM), Max Step and Ruggedness.

11:30AM *Coevolutionary Genetic Algorithm for Variable Ordering in CSPs [#E-14098]*

Muhammad Rezaul Karim and Malek Mouhoub, University of Regina, Canada

A Constraint Satisfaction Problem (CSP) is a framework used for modeling and solving constrained problems. Tree-search algorithms like backtracking try to construct a solution to a CSP by selecting the variables of the problem

one after another. The order in which these algorithm select the variables potentially have significant impact on the search performance. Various heuristics have been proposed for choosing good variable ordering. Many powerful variable ordering heuristics weigh the constraints first and then utilize the weights for selecting good order of the variables. Constraint weighting are basically employed to identify global bottlenecks in a CSP. In this paper, we propose a new approach for learning weights for the constraints using competitive coevolutionary Genetic Algorithm (GA). Weights learned by the coevolutionary GA later help to make better choices for the first few variables in a search. In the competitive coevolutionary GA, constraints and candidate solutions for a CSP evolve together through an inverse fitness interaction process. We have conducted experiments on several random, quasi- random and patterned instances to measure the efficiency of the proposed approach. The results and analysis show that the proposed approach is good at learning weights to distinguish the hard constraints for quasi-random instances and forced satisfiable random instances generated with the Model RB. For other type of instances, RNDI still seems to be the best approach as our experiments show.

11:50AM *A Co-Evolutionary Multi-Objective Approach for a K-Adaptive Graph-Based Clustering Algorithm [#E-14321]*

Hector D. Menendez, David F. Barrero and David Camacho, Universidad Autonoma de Madrid, Spain; Universidad de Alcala, Spain

Clustering is a field of Data Mining that deals with the problem of extract knowledge from data blindly. Basically, clustering identifies similar data in a dataset and groups them in sets named clusters. The high number of clustering practical applications has made it a fertile research topic with several approaches. One recent method that is gaining popularity in the research community is Spectral Clustering (SC). It is a clustering method that builds a similarity graph and applies spectral analysis to preserve the data continuity in the cluster. This work presents a new algorithm inspired by SC algorithm, the Co-Evolutionary Multi-Objective Genetic Graphbased Clustering (CEMOG) algorithm, which is based on the Multi-Objective Genetic Graph-based Clustering (MOGGC) algorithm and extends it by introducing an adaptative number of clusters. CEMOG takes an island-model approach where each island keeps a population of candidate solutions for ki clusters. Individuals in the islands can migrate to encourage genetic diversity and the propagation of individuals around promising search regions. This new approach shows its competitive performance, compared to several classical clustering algorithms (EM, SC and K-means), through a set of experiments involving synthetic and real datasets.

12:10PM *Evolving Multiplication as Emergent Behavior in Cellular Automata Using Conditionally Matching Rules [#E-14640]*

Michal Bidlo, Brno University of Technology, Czech Republic

In this paper a special representation technique called conditionally matching rules will be applied in order to design computational processes in uniform cellular automata. The goal is to verify abilities of this approach in combination with genetic algorithm on the problem of disigning various cellular automata that exhibit a given computational process. The principle of a computational process in a cellular automaton is to interpret some cells as input bits and some (possibly other) cells as output bits (i.e. the result of the computation). The genetic algorithm is applied to find a suitable transition function of a cellular automaton according to which the given computation could be observed during its development for all the possible binary combinations stored in the input cells. Both the input values and the result is represented by state values of cells. The input of the computation will be represented by the initial state of the cellular automaton. After a finite number of development steps the cells representing the output bits are expected to contain the result of the computation. A set of experiments will be performed considering various setups of the evolutionary system and arrangements of the target computation. It will be shown that non-trivial computations can be realized in a uniform two-dimensional cellular array.

FrE2-4 Biometrics, Bioinformatics and Biomedical Applications

Friday, July 11, 10:30AM-12:30PM, Room: 203D, Chair: Mengjie Zhang

10:30AM *Combining Graph Connectivity and Genetic Clustering to Improve Biomedical Summarization [#E-14322]*

Hector D. Menendez, Laura Plaza and David Camacho, Universidad Autonoma de Madrid, Spain; Universidad Nacional de Educacion a Distancia, Spain

Automatic summarization is emerging as a feasible instrument to help biomedical researchers to access online literature and face information overload. The Natural Language Processing community is actively working toward the development of effective summarization applications; however, they are sometimes less informative than the user needs. In this work, our aim is to improve a summarization graph-based process combining genetic clustering with graph connectivity information. In this way, while genetic clustering allows us to identify the different topics that are dealt with in a document, connectivity information (in particular, degree centrality) allows us to asses and exploit the relevance of the different topics. Our automatic summaries are compared with others produced by commercial and research applications, to demonstrate the appropriateness of using this combination of techniques for automatic summarization.

10:50AM *Selecting the Optimal EEG Electrode Positions for a Cognitive Task Using an Artificial Bee Colony with Adaptive Scale Factor Optimization Algorithm [#E-14673]*

Shreyasi Datta, Pratyusha Rakshit, Amit Konar and Atulya Nagar, Jadavpur University, India; Liverpool Hope University, England

The present work introduces a proposed Artificial Bee Colony with Adaptive Scale Factor (ABC-ASF) optimization algorithm-based optimal electrode selection strategy from which the acquired EEG signals enlighten the major brain activities involved in a cognitive task. In ABC-ASF, the scale factor for mutation in traditional Artificial Bee Colony is self adapted by learning from the previous experiences. Experimental results obtained from the real framework of estimating optimal electrodes indicate that the proposed algorithm outperforms other state-of-art techniques with respect to computational accuracy and run-time complexity.

11:10AM *A New GP-Based Wrapper Feature Construction Approach to Classification and Biomarker Identification [#E-14214]*

Soha Ahmed, Mengjie Zhang and Lifeng Peng, Victoria University of Wellington, New Zealand

Mass spectrometry (MS) is a technology used for identification and quantification of proteins and metabolites. It helps in the discovery of proteomic or metabolomic biomarkers, which aid in diseases detection and drug discovery. The detection of biomarkers is performed through the classification of patients from healthy samples. The mass spectrometer

produces high dimensional data where most of the features are irrelevant for classification. Therefore, feature reduction is needed before the classification of MS data can be done effectively. Feature construction can provide a means of dimensionality reduction and aims at improving the classification performance. In this paper, genetic programming (GP) is used for construction of multiple features. Two methods are proposed for this objective. The proposed methods work by wrapping a Random Forest (RF) classifier to GP to ensure the quality of the constructed features. Meanwhile, five other classifiers in addition to RF are used to test the impact of the constructed features on the performance of these classifiers. The results show that the proposed GP methods improved the performance of classification over using the original set of features in five MS data sets.

11:30AM *An Examination of Synchronisation in Artificial Gene Regulatory Networks [#E-14356]*

Jonathan Byrne, Miguel Nicolau, Anthony Brabazon and Michael O'Neill, University College Dublin, Ireland

An Artificial Genetic Regulatory Network (GRN) is a model of the gene expression regulation mechanism in biological organisms. It is a dynamical system that is capable of mimicking non-linear time series. The GRN was adapted to allow for input and output so that the system's rich dynamics could be used for dynamic problem solving. In order for the GRN to be embedded in the environment, the time scale of the physical system has to be mapped to that of the GRN and so a synchronisation process was introduced. This work examines the impact of different synchronisation intervals and how they effect the overall performance of the GRN. A variable synchronisation step that stops once the system has stabilised is also explored as a mechanism for automatically choosing the interval size.

11:50AM *Memetic Algorithm for Sorting Unsigned Permutations by Reversals [#E-14374]*

Jose Luis Soncco-Alvarez and Mauricio Ayala-Rincon, Universidade de Brasilia, Brazil

Sorting by reversals unsigned permutations is a problem exhaustively studied in the fields of combinatorics of permutations and bioinformatics with crucial applications in the analysis of evolutionary distance between organisms. This problem was shown to be NP-hard, which gave rise to the development of a series of approximation and heuristic algo- rithms. Among these approaches, evolutionary algorithms were also proposed, from which to the best of our knowledge a parallel version of the first proposed genetic algorithm computes the highest quality results. These solutions were not optimized for the case when the population reaches a degenerate state, that is when individuals of the population remain very similar, and the procedure still continues consuming computational resources, but without improving the individuals. In this paper, a memetic algorithm is proposed for sorting unsigned permutations by reversals, using the local search as a way to improve the fitness function image of the individuals. Also, the entropy of the population is controlled, such that, when a degenerate state is reached the population is restarted. Several experiments were performed using permutations generated from biological data as well as hundreds of randomly generated permutations of different size, from which some ones were chosen and used as benchmark permutations. Experiments have shown that the pro- posed memetic algorithm uses more adequately the computational resources and gives competitive results in comparison with the parallel genetic algorithm and outperforms the results of the standard genetic algorithm.

12:10PM *Evolved Neural Networks for HIV-1 Co-Receptor Identification [#E-14810]*

Gary Fogel, Enoch Liu, Marco Salemi, Susanna Lamers and Michael McGrath, Natural Selection, Inc., United States; University of Florida, United States; BioInfoExperts, LLC, United States; University of California, United States

HIV-1 infects a variety of cell types such as macrophages, T-cells and dendritic cells by expressing different chemokine receptors. R5 HIV-1 viruses use the CCR5 co-receptor for entry, X4 viruses use the CXCR4 co-receptor, and several viral strains make use of both co-receptors (a so-called "dual tropic" or R5X4 virus). Both X4 and R5X4 viruses are associated with late stage rapid progression to AIDS. It remains difficult to identify viral co-receptor type in advance of treatment, especially the R5X4 variety. In this paper we extended previous work to classify HIV-1 tropism using evolved neural networks and a larger set of HIV-1 sequences and features to improve overall classification accuracy.

FrE2-5 Robotics and Engineering Applications

Friday, July 11, 10:30AM-12:30PM, Room: 303, Chair: Amiram Moshaiov

10:30AM *Analysis of Fitness Noise in Particle Swarm Optimization: From Robotic Learning to Benchmark Functions [#E-14610]*

Ezequiel Di Mario, Inaki Navarro and Alcherio Martinoli, Ecole Polytechnique Federale de Lausanne, Switzerland

Population-based learning techniques have been proven to be effective in dealing with noise and are thus promising tools for the optimization of robotic controllers, which have inherently noisy performance evaluations. This article discusses how the results and guidelines derived from tests on benchmark functions can be extended to the fitness distributions encountered in robotic learning. We show that the large-amplitude noise found in robotic evaluations is disruptive to the initial phases of the learning process of PSO. Under these conditions, neither increasing the population size nor increasing the number of iterations are efficient strategies to improve the performance of the learning. We also show that PSO is more sensitive to good spurious evaluations of bad solutions than bad evaluations of good solutions, i.e., there is a non-symmetric effect of noise on the performance of the learning.

10:50AM *A Comparison of Neural Networks and Physics Models as Motion Simulators for Simple Robotic Evolution [#E-14678]*

Christiaan Pretorius, Mathys du Plessis and John Gonsalves, Nelson Mandela Metropolitan University, South Africa

Robotic simulators are used extensively in Evolutionary Robotics (ER). Such simulators are typically constructed by considering the governing physics of the robotic system under investigation. Even though such physics-based simulators have seen wide usage in ER, there are some potential challenges involved in their construction and usage. An alternative approach to developing robotic simulators for use in ER, is to sample data directly from the robotic system and construct simulators based solely on this data. The authors have previously shown the viability of this approach by training Artificial Neural Networks (ANNs) to act as simulators in the ER process. It is, however, not known how this approach to simulator construction will compare to physics-based approaches, since a comparative study between ANN-based and physics-based robotic simulators in ER has not yet been conducted. This paper describes such a comparative study. Robotic simulators for the motion of a differentially-steered mobile robot were constructed using both ANN-based and physics-based approaches. These two approaches were then compared by employing each of the developed simulators in the ER process to evolve simple navigation controllers for the experimental robot in simulation. Results obtained indicated that, for the

robotic system investigated in this study, ANN-based robotic simulators offer a promising alternative to physics-based simulators.

11:10AM *Family Bootstrapping: A Genetic Transfer Learning Approach for Onsetting the Evolution for a Set of Related Robotic Tasks [#E-14708]*

Amiram Moshaiov and Amir Tal, Tel-Aviv University, Israel

Studies on the bootstrap problem in evolutionary robotics help lifting the barrier from the way to evolve robots for complex tasks. It remains an open question, though, how to reduce the need for designer knowledge when devising a bootstrapping approach for any particular complex task. Transfer learning may help reducing this need and support the evolution of solutions to complex tasks, through task relatedness. Relying on the commonalities of similar tasks, we introduce a new concept of Family Bootstrapping (FB). FB refers to the creation of biased ancestors that are expected to onset the evolution of "a family" of solutions not just for one task, but for a set of related robot tasks. A general FB paradigm is outlined and the unique potential of the proposed concept is discussed. To highlight the validity of the FB concept, a simple demonstration case, concerning the evolution of neuro-controllers for a set of robot navigation tasks, is provided. The paper is concluded with some suggestions for future research.

11:30AM *Is MO-CMA-ES Superior to NSGA-II for the Evolution of Multi-Objective Neuro-Controllers? [#E-14439]*

Amiram Moshaiov and Omer Abramovich, Tel-Aviv University, Israel

In the last decade evolutionary multi-objective optimizers have been employed in studies concerning evolutionary robotics. In particular, the majority of such studies involve the evolution of neuro-controllers using either a genetic algorithm approach or an evolution strategies approach. Given the fundamental difference between these types of search mechanisms, a valid question is which kind of multi-objective optimizer is better for such applications. This question, which is dealt with here, is raised in view of the permutation problem that exists in evolutionary neural-networks. Two well-known Multi-objective Evolutionary Algorithms are used in the current comparison, namely MO-CMA-ES and NSGA-II. A multi-objective navigation problem is used for the testing, which is known to suffer from a local Pareto problem. For the employed simulation case MO-CMA-ES is better at finding a large sub-set of the approximated Pareto-optimal neuro-controllers, whereas NSGA-II is better at finding a complementary sub-set of the optimal controllers. This suggests that, if this phenomenon persists over a large range of case studies, then future studies should consider some modifications to such algorithms for the multi-objective evolution of neuro-controllers.

11:50AM *Optimization of the Picking Sequence of an Automated Storage and Retrieval System (AS/RS) [#E-14080]*

Rolf Dornberger, Thomas Hanne, Remo Ryter and Stauffer Michael, University of Applied Sciences and Arts Northwestern Switzerland, Switzerland

In this paper we consider the problem of an optimal picking order sequence in a multi-aisle warehouse that is operated by a single automatic storage and retrieval system (AS/RS). The problem is solved by using a genetic algorithm (GA) similar to the one in the earlier research. The problem and the solution approach are implemented in the OpenOpal software which provides a suitable test bed for simulation and optimization (see http://www.openopal.org/). As a result it becomes evident that the genetic algorithm can be improved by changing the selection method and introducing an elitism mechanism.

12:10PM *Practical Application of an Evolutionary Algorithm for the Design and Construction of a Six-Inch Submarine [#E-14103]*

Khairul Alam, Tapabrata Ray and Sreenatha G. Anavatti, University of New South Wales, Australia

Unmanned underwater vehicles (UUVs) are becoming an attractive option for maritime search and survey operations as they are cheap and efficient compared to conventional use of divers or manned submersibles. Consequently, there has been a growing interest in UUV research among scientific and engineering communities. Although UUVs have received significant research interest in recent years, limited attention has been paid towards design and development of mini/micro UUVs (usually less than 1 foot in length). Micro UUVs are particularly attractive for deployment in extraordinarily confined spaces such as inspection of intricate underwater structures, ship wrecks, oil pipe lines or extreme hazardous areas. This paper considers previous work done in the field of miniature UUVs and presents an optimization framework for preliminary design of that class of UUVs. A state-of- the-art optimization algorithm namely infeasibility driven evolutionary algorithm (IDEA) is used to carry out optimization of the micro UUV designs. The framework is subsequently used to identify optimal design of a torpedo-shaped micro UUV with an overall length of six inches (152.4 mm). The preliminary design identified through the process of optimization is further analyzed with the help of a computer-aided design tool to come up with a detailed design. The final design has since then been built and is currently undergoing trials.

Friday, July 11, 1:30PM-3:30PM

FrE3-1 Large-Scale Problems and Real-World Applications

Friday, July 11, 1:30PM-3:30PM, Room: 203A, Chair: Ke Tang

1:30PM *A Novel Hybridization of Opposition-Based Learning and Cooperative Co-Evolutionary for Large-Scale Optimization [#E-14840]*

Borhan Kazimipour, Mohammad Nabi Omidvar, Xiaodong Li and A. K. Qin, RMIT University, Australia

Opposition-based learning (OBL) and cooperative co-evolution (CC) have demonstrated promising performance when dealing with large-scale global optimization (LSGO) problems. In this work, we propose a novel framework for hybridizing these two techniques, and investigate the performance of simple implementations of this new framework using the most recent LSGO benchmarking test suite. The obtained results verify the effectiveness of our proposed OBL-CC framework. Moreover, some advanced statistical analyses reveal that the proposed hybridization significantly outperforms its component methods in terms of the quality of finally obtained solutions.

1:50PM *Optimising Large Scale Public Transport Network Design Problems Using Mixed-Mode Parallel Multi-Objective Evolutionary Algorithms [#E-14306]*

Ian Cooper, Matthew John, Rhydian Lewis, Andrew Olden and Christine Mumford, Cardiff University, United Kingdom

In this paper we present a novel tool, using both OpenMP and MPI protocols, for optimising the efficiency of Urban Transportation Systems within a defined catchment, town or city. We build on a previously presented model which uses a Genetic Algorithm with novel genetic operators to optimise route sets

and provide a transport network for a given problem set. This model is then implemented within a Parallel Multi-Objective Genetic Algorithm and demonstrated to be scalable to within the scope of real world, [city- wide], problems. This paper compares and contrasts three methods of parallel distribution of the Genetic Algorithm's computational workload: a job farming algorithm and two variations on an `Islands' approach. Results are presented in the paper from both single and mixed mode strategies. The results presented are from a range of previously published academic problem sets. Additionally a real world inspired problem set is evaluated and a visualisation of the optimised output is given.

2:10PM *Many-Objective Evolutionary Computation for Optimization of Separated-Flow Control Using a DBD Plasma Actuator [#E-14777]*

Takeshi Watanabe, Tomoaki Tatsukawa, Antonio Lopez Jaimes, Hikaru Aono, Taku Nonomura, Akira Oyama and Kozo Fujii, ISAS/JAXA, Japan

In this paper, an algorithm for many-objective evolutionary computation, which is based on the NSGA-II with the Chebyshev preference relation, is applied to multi-objective design optimization problem of dielectric barrier discharge plasma actuator (DBDPA). The present optimization problem has four design parameters and six objective functions. The main goal of the paper is to extract useful design guidelines to predict control flow behavior based on the DBDPA parameter values using the resulting approximation Pareto set obtained by the optimization.

2:30PM *A Hybrid EA for High-Dimensional Subspace Clustering Problem [#E-14206]*

Lin Lin, Gen Mitsuo and Liang Yan, Dalian University of Technology, China; Fuzzy Logic Systems Institute, Japan

Considering Particle Swarm Optimization (PSO) could enhance solutions generated during the evolution process by exploiting their social knowledge and individual memory, we used PSO as a local search strategy in Genetic Algorithm (GA) framework for fine tuning the search space. GA is to make sure that every region of the search space is covered so that we have a reliable estimate of the global optimal solution and PSO is for further pruning the good solutions by searching around the neighborhood. In this paper, proposed approach is used for subspace clustering, which is an extension of traditional clustering that seeks to find clustering in different subspaces within a dataset. Subspace clustering is to find a subset of dimensions on which to improve cluster quality by removing irrelevant and redundant dimensions in high dimensions problems. The experimental results demonstrate the positive effects of PSO as a local optimizer.

2:50PM *A Simplified Glowworm Swarm Optimization Algorithm [#E-14400]*

Ming-yu Du, Xiu-juan Lei and Zhen-qiang Wu, Shaanxi Normal University, China

Aimed at the poor optimizing ability and the low accuracy of the glowworm swarm optimization algorithm (GSO), a simplified glowworm swarm optimization algorithm (SGSO) was put forward in this paper, which omitted the phases of seeking dynamic decision domain and movement probability calculation, and meanwhile simplified the location updating process. Moreover, elitism was introduced to improve the capacity of searching optimal solution. It was applied to the unimodal and multimodal benchmark function optimization problems. The improved SGSO algorithm is compared with the basic GSO and other swarm intelligent optimization algorithms to demonstrate the performance. Experimental results showed that SGSO improves not only the precision but also the efficiency in function optimization.

3:10PM *An Improved Two Archive Algorithm for Many-Objective Optimization [#E-14556]*

Bingdong Li, Jinlong Li, Ke Tang and Xin Yao, University of Science and Technology of China, China; University of Birmingham, United Kingdom

Multi-Objective Evolutionary Algorithms have been deeply studied in the research community and widely used in the real-world applications. However, the performance of traditional Pareto-based MOEAs, such as NSGA-II and SPEA2, may deteriorate when tackling Many-Objective Problems, which refer to the problems with at least four objectives. The main cause for the degradation lies in that the high-proportional non-dominated solutions severely weaken the differentiation ability of Pareto-dominance. This may lead to stagnation. The Two Archive Algorithm (TAA) uses two archives, namely Convergence Archive (CA) and Diversity Archive (DA) as non-dominated solution repositories, focusing on convergence and diversity respectively. However, as the objective dimension increases, the size of CA increases enormously, leaving little space for DA. Besides, the update rate of CA is quite low, which causes severe problems for TAA to drive forth. Moreover, since TAA prefers DA members that are far away from CA, DA might drag the population backwards. In order to deal with these weaknesses, this paper proposes an improved version of TAA, namely ITAA. Compared to TAA, ITAA incorporates a ranking mechanism for updating CA which enables truncating CA while CA overflows. Besides, a shifted density estimation technique is embedded to replace the old ranking method in DA. The efficiency of ITAA is demon strated by the experimental studies on benchmark problems with up to 20 objectives.

FrE3-2 Evolvable Hardware and Software and Genetic Programming

Friday, July 11, 1:30PM-3:30PM, Room: 203B, Chair: Andy Song

1:30PM *Two Step Evolution Strategy for Device Motif BSIM Model Parameter Extraction [#E-14619]*

Yang Xiao, Martin Trefzer, James Walker, Simon Bale and Andy Tyrrell, University of York, United Kingdom

The modeling and simulation of semiconductor devices is a difficult and computationally intensive task. However the expense of fabrication and testing means that accurate modeling and simulation are crucial to the continued progress of the industry. To create these models and then perform the simulations requires parameters from accurate physical models to be obtained and then more abstract models created that can perform more complex circuit simulations. Device models (motifs) are created as a mitigation technique for improvement the circuit performance and as technology advances to help with the effects of transistor variability. In order to explore the characteristics of new device motifs on circuit designs, obtaining accurate and reliable device models becomes the first problem for designers. In this paper a Two Step Evolution Strategy (2SES) is proposed for device parameter model extraction. The proposed 2SES approach automatically extracts a set of parameters with respect to a specified device model. Compared with conventional mathematical extraction approach, 2SES is an efficient and accurate method to solve the parameter extraction problem and simultaneously addresses the fact of the mathematical extraction having the complexity of Multi-objective optimization. Compared with single step ES extract result, it is shown that the two-step ES extraction process continues improving generations by adjusting the optimization parameters. Finally, an application of a new device motif on circuit design is given at end of the paper and compared against a standard device.

1:50PM *Maximising Axiomatization Coverage and Minimizing Regression Testing Time [#E-14238]*

Markus Wagner, The University of Adelaide, Australia

The correctness of program verification systems is of great importance, as they are used to formally prove that safety- and security-critical programs follow their specification. One of the contributing factors to the correctness of the whole verification system is the correctness of the background axiomatization, which captures the semantics of the target program language.

We present a framework for the maximization of the proportion of the axiomatization that is used ("covered") during testing of the verification tool. The diverse set of test cases found not only increases the trust in the verification system, but it can also be used to reduce the time needed for regression testing.

2:10PM *A New Adaptive Kalman Filter by Combining Evolutionary Algorithm and Fuzzy Inference System [#E-14223]*

Yudan Huo, Zhihua Cai, Wenyin Gong and Qin Liu, China University of Geosciences (Wuhan), China

The performance of the Kalman filter (KF), which is recognized as an outstanding tool for dynamic system state estimation, heavily depends on its parameter R, called the measurement noise covariance matrix. However, it's difficult to get the exact value of R before the filter starts, and the value of R is likely to change with the measurement environment when the filter is working. To solve this problem, a new parameter adaptive Kalman filter is proposed in this paper. In this new Kalman filter, the initial value of R is offline decided by Evolutionary Algorithm (EA), and the value of R decided by EA is online updated by Fuzzy Inference System (FIS). A simulation experiment based on target tracking is carried out, and the results demonstrate that the new adaptive Kalman filter proposed in this paper (HydGeFuzKF) has a stronger adaptability to time-varying measurement noises than regular Kalman filter (RegularKF), Sage-Husa adaptive Kalman filter (SageHusaKF), the adaptive Kalman filter only based on genetic algorithm (GeneticKF) and the adaptive Kalman filter only based on fuzzy inference system (FuzzyKF).

2:30PM *Cartesian Genetic Programming as Local Optimizer of Logic Networks [#E-14240]*

Lukas Sekanina, Ondrej Ptak and Zdenek Vasicek, Brno University of Technology, Czech Republic

Logic synthesis and optimization methods work either globally on the whole logic network or locally on preselected subnetworks. Evolutionary design methods have already been applied to evolve and optimize logic circuits at the global level. In this paper, we propose a new method based on Cartesian genetic programming (CGP) as a local area optimizer in combinational logic networks. First, a subcircuit is extracted from a complex circuit, then the subcircuit is optimized by CGP and finally the optimized subcircuit replaces the original one. The procedure is repeated until a termination criterion is satisfied. We present a performance comparison of local and global evolutionary optimization methods with a conventional approach based on ABC and analyze these methods using differently pre-optimized benchmark circuits. If a sufficient time is available, the proposed locally optimizing CGP gives better results than other locally operating methods reported in the literature; however, its performance is significantly worse than the evolutionary global optimization.

2:50PM *Wave Height Quantification Using Land Based Seismic Data with Grammatical Evolution [#E-14696]*

Sarah Donne, Miguel Nicolau, Christopher Bean and Michael O'Neill, University College Dublin, Ireland

Accurate, real time, continuous ocean wave height measurements are required for the initialisation of ocean wave forecast models, model hindcasting, and climate studies. These measurements are usually obtained using in situ ocean buoys or by satellite altimetry, but are sometimes incomplete due to instrument failure or routine network upgrades. In such situations, a reliable gap filling technique is desirable to provide a continuous and accurate ocean wave field record. Recorded on a land based seismic network are continuous seismic signals known as microseisms. These microseisms are generated by the interactions of ocean waves and will be used in the estimation of ocean wave heights. Grammatical Evolution is applied in this study to generate symbolic models that best estimate ocean wave height from terrestrial seismic data, and the best model is validated against an Artificial Neural Network. Both models are tested over a five month period of 2013, and an analysis of the results obtained indicates that the approach is robust and that it is possible to estimate ocean wave heights from land based seismic data.

3:10PM *Genetic Programming Based Activity Recognition on a Smartphone Sensory Data Benchmark [#E-14834]*

Feng Xie, Andy Song and Vic Ciesielski, RMIT University, Australia

Activity recognition from smartphone sensor inputs is of great importance to enhance user experience. Our study aims to investigate the applicability of Genetic Programming (GP) approach on this complex real world problem. Traditional methods often require substantial human efforts to define good features. Moreover the optimal features for one type of activity may not be suitable for another. In comparison, our GP approach does not require such feature extraction process, hence, more suitable for complex activities where good features are difficult to be pre-defined. To facilitate this study we therefore propose a benchmark of activity data collected from various smartphone sensors, as currently there is no existing publicly available database for activity recognition. In this study, a GP-based approach is applied to nine types of activity recognition tasks by directly taking raw data instead of features. The effectiveness of this approach can be seen by the promising results. In addition our benchmark data provides a platform for other machine learning algorithms to evaluate their performance on activity recognition.

FrE3-3 Swarm Intelligence

Friday, July 11, 1:30PM-3:30PM, Room: 203C, Chair: Thomas Runkler

1:30PM *Swarm/Evolutionary Intelligence for Agent-Based Social Simulation [#E-14721]*

Andreas Janecek, Tobias Jordan and Fernando Buarque de Lima-Neto, University of Vienna, Austria; University of Pernambuco, Brazil

Several micro economic models allow to evaluate consumer's behavior using a utility function that is able to measure the success of an individual's decision. Such a decision may consist of a tuple of goods an individual would like to buy and hours of work necessary to pay for them. The utility of such a decision depends not only on purchase and consumption of goods, but also on fringe benefits such as leisure, which additionally increases the utility to the individual. Utility can be used then as a collective measure for the overall evaluation of societies. In this paper, we present and compare three different agent based social simulations in which the decision finding process of consumers is performed by three algorithms from swarm intelligence and evolutionary computation. Although all algorithms appear to be suitable for the underlying problem as they are based on historical information and also contain a stochastic part which allows for modeling the uncertainty and bounded rationality, they differ greatly in terms of incorporating historical information used for finding new alternative decisions. Newly created decisions that violate underlying budget constraints may either be mapped back to the feasible region, or may be allowed to leave the valid search space. However, in order to avoid biases that would disrupt the inner rationale of each meta heuristic, such invalid decisions are not remembered in the future. Experiments indicate that the choice of such bounding strategy varies according to the choice of the optimization algorithm. Moreover, it seems that each of the techniques could excel in identifying different types of individual behavior such as risk affine, cautious and balanced.

1:50PM *Solving the Multidimensional Knapsack Problem Using a CUDA Accelerated PSO [#E-14647]*

Drahoslav Zan and Jiri Jaros, Brno University of Technology, Czech Republic

The Multidimensional Knapsack Problem (MKP) represents an important model having numerous applications in combinatorial optimisation, decision-making and scheduling processes, cryptography, etc. Although the MKP is easy to define and implement, the time complexity of finding a good solution grows exponentially with the problem size. Therefore, novel software techniques and hardware platforms are being developed and employed to reduce the computation time. This paper addresses the possibility of solving the MKP using a GPU accelerated Particle Swarm Optimisation (PSO). The goal is to evaluate the attainable performance benefit when using a highly optimised GPU code instead of an efficient multi-core CPU implementation, while preserving the quality of the search process. The paper shows that a single Nvidia GTX 580 graphics card can outperform a quad-core CPU by a factor of 3.5 to 9.6, depending on the problem size. As both implementations are memory bound, these speed-ups directly correspond to the memory bandwidth ratio between the investigated GPU and CPU.

2:10PM *Multidimensional Scaling with Multiswarming [#E-14011]*

Thomas Runkler and James Bezdek, Siemens Corporate Technology, Germany; University of Melbourne, Australia

We introduce a new method for multidimensional scaling in dissimilarity data that is based on preservation of metric topology between the original and derived data sets. The model seeks neighbors in the derived data that have the same ranks as in the input data. The algorithm we use to optimize the model is a modification of particle swarm optimization called multiswarming. We compare the new method to three well known approaches: Principal component analysis, Sammon's method, and (Kruskal's) metric MDS. Our method produces feature vector realizations that compare favorably with the other approaches on three real relational data sets.

2:30PM *Chaos-Driven Discrete Artificial Bee Colony [#E-14121]*

Magdalena Metlicka and Donald Davendra, VSB - Technical University of Ostrava, Czech Republic

In this paper, a chaos driven Discrete Artificial Bee Algorithm is introduced. The main premise of this work is to ascertain if using chaos maps in lieu of standard pseudorandom number generators can improve the performance of the canonical algorithm. Nine unique chaos maps are embedded in the Discrete Artificial Bee Algorithm alongside the Mersenne twister and evaluated on the lot-streaming flowshop scheduling problem with setup time. Based on the obtained results, a number of chaotic maps significantly improve the performance of the algorithm. Additionally, the new algorithm is favourably compared with the chaos driven Enhanced Differential Evolution algorithm for the same problem.

2:50PM *Web Bots Detection Using Particle Swarm Optimization Based Clustering [#E-14847]*

Shafiq Alam, Gillian Dobbie, Yun Sing Koh and Patricia Riddle, University of Auckland, New Zealand

Optimization based techniques have emerged as important methods to tackle the problems of efficiency and accuracy in data mining. One of the current application areas is outlier detection which has not been fully explored yet but has enormous potential. Web bots are an example of outliers, which can be found in the web usage analysis process. Web bot requests are different from a genuine web user as web bots crawl large numbers of pages in a very short time. If web bots remains undetected they can skew the analysis process which can result in incorrect patterns that can cause wrong decisions. In this paper we use one of the popular Swarm Intelligence (SI) based techniques called Particle Swarm Optimization (PSO) to detect web bots among genuine users request. We use our Particle Swarm Optimization (PSO) based clustering algorithm, Hierarchical Particle Swarm Optimization based clustering (HPSO-clustering) to cluster the web- usage data and detect the abnormal behaviour caused by the web bots. We present the results of detection which shows that our proposed approach is capable of detecting such abnormal behaviour. We then compare the characteristics of the detected web bots with genuine web-users using cross validation.

3:10PM *An Ant Colony Optimization Algorithm for Multi-Objective Clustering in Mobile Ad Hoc Networks [#E-14495]*

Chung-Wei Wu, Tsung-Che Chiang and Li-Chen Fu, National Taiwan University, Taiwan; National Taiwan Normal University, Taiwan

Due to the proliferation of smart mobile devices and the developments in wireless communication, mobile ad hoc networks (MANETs) are gaining more and more attention in recent years. Routing in MANETs is a challenge, especially when the network contains a large number of nodes. The clustering technique is a popular method to organize the nodes in MANETs. It divides the network into several clusters and assigns a cluster head to each cluster for intra- and inter-cluster communication. Clustering is NP-hard and needs to consider multiple objectives. In this paper we propose a Pareto-based ant colony optimization (ACO) algorithm to deal with this multiobjective optimization problem. A new encoding scheme is proposed to reduce the size of search space, and a new decoding scheme is proposed to generate high-quality solutions effectively. Experimental results show that our approach is better than several benchmark approaches.

FrE3-4 Heuristics, Metaheuristics and Hyper-Heuristics II

Friday, July 11, 1:30PM-3:30PM, Room: 203D, Chair: Madalina Drugan

1:30PM *Designing Reusable Metaheuristic Methods: A Semi-Automated Approach [#E-14713]*

Steven Adriaensen, Tim Brys and Ann Nowe, Vrije Universiteit Brussel, Belgium

Many interesting optimization problems cannot be solved efficiently. Recently, a lot of work has been done on metaheuristic optimization methods that quickly find approximate solutions to otherwise intractable problems. While successful, the field suffers from a notable lack of reuse of methods, both in practical applications as in research. In this paper, we describe a semi-automated approach to design more re-usable methods, based on key principles of re-usability such as simplicity, modularity and generality. We illustrate this methodology by designing general metaheuristics (using hyperheuristics) and show that the methods obtained are competitive with the contestants of the Cross-Domain Heuristic Search Competition (2011). In particular, we find a method performing better than the competition's winner, which can be considered the state-of-the-art in domain-independent metaheuristic search.

1:50PM *Network Path Optimization Under Dynamic Conditions [#E-14764]*

Yaser Enaya and Kalyanmoy Deb, Michigan State University, United States

Most network optimization problems are studied under a static scenario in which connectivity of the network and weights associated with the links of the networks are assumed to be fixed. However, in practice, they are likely to change with time and if the network is to be used over time under dynamic conditions, they need to be re-optimized as soon as there is a change. Since optimization process requires some finite time, there is a need for a efficient dynamic optimization strategy for solving such problems. In this study, we extend a previously proposed "Frozen-time" algorithm to network optimization by which new and optimized networks can be obtained in a computationally fast manner. We propose three different variations of the optimization strategies and show proof-of-principle simulation results on a 20-node network having 190 different source-destination paths. The results are interesting and suggest a viable further research.

2:10PM *A Parallel Lagrangian-ACO Heuristic for Project Scheduling [#E-14587]*

Oswyn Brent, Dhananjay Thiruvady, Antonio Gomez-Iglesias and Rodolfo Garcia-Flores, Commonwealth Scientific and Industrial Research Organisation, Australia

In this paper we present a parallel implementation of an existing Lagrangian heuristic for solving a project scheduling problem. The original implementation uses Lagrangian relaxation to generate useful upper bounds and guidance towards generating good lower bounds or feasible solutions. These solutions are further improved with Ant Colony Optimisation via loose and tight couplings. While this approach has proven to be effective, there are often large gaps for a number of the problem instances. Thus, we aim to improve the performance of this algorithm through a parallel implementation on a multicore shared memory architecture. However, the original algorithm is inherently sequential and is not trivially parallelisable due to the dependencies between the different components involved. Hence, we propose different approaches to carry out this parallelisation. Our results show that the parallel version produces consistently better results given the same time limits.

2:30PM *A Multidirectional Physarum Solver for the Automated Design of Space Trajectories [#E-14149]*

Luca Masi and Massimiliano Vasile, University of Strathclyde, United Kingdom

This paper proposes a bio-inspired algorithm to automatically generate optimal multi-gravity assist trajecto- ries. The multi-gravity assist problem has some analogies with the better known Traveling Salesman Problem and can be addressed with similar strategies. An algorithm drawing inspiration from the Physarum slime mould is proposed to grow and explore a tree of decisions that corresponds to the possible sequences of transfers from one planet to another. Some examples show that the proposed bio-inspired algorithm can produce solutions that are better than the ones generated by humans or with Hidden Genes Genetic Algorithms.

2:50PM *A Genetic Programming-Based Hyper-heuristic Approach for Storage Location Assignment Problem [#E-14765]*

Jing Xie, Yi Mei, Andreas Ernst, Xiaodong Li and Andy Song, RMIT University, Australia; Commonwealth Scientific and Industrial Research Organisation, Australia

This study proposes a method for solving real-world warehouse Storage Location Assignment Problem (SLAP) under grouping constraints by Genetic Programming (GP). Integer Linear Programming (ILP) formulation is used to define the problem. By the proposed GP method, a subset of the items is repeatedly selected and placed into the available current best location of the shelves in the warehouse, until all the items have been assigned with locations. A heuristic matching function is evolved by GP to guide the selection of the subsets of items. Our comparison between the proposed GP approach and the traditional ILP approach shows that GP can obtain near-optimal solutions on the training data within a short period of time. Moreover, the evolved heuristics can achieve good optimization results on unseen scenarios, comparable to that on the scenario used for training. This shows that the evolved heuristics have good reusability and can be directly applied for slightly different scenarios without any new search process.

3:10PM *The Monarchy Driven Optimization Algorithm [#E-14598]*

Ritambhar Burman, Swagatam Das, Zheshanul Haque, Athanasios V. Vasilakos and Soumyadip Chakraborti, Jadavpur University, India; Indian Statistical Institute, India; Kuwait University, Kuwait

We present a novel human society inspired algorithm for single-objective bound constrained optimization. The proposed Monarchy Driven Optimization (MDO) algorithm is a population-based iterative global optimization technique for multi-dimensional and multi-modal problems. At its core, this technique introduces a monarchial society where the outlook of its population is fashioned by the thoughts of individuals and the monarch. A detailed study including the tuning of MDO parameters is presented along with the theory. It is applied to standard benchmark functions comprising uni-modal and multi-modal as well as rotated functions. The results section suggests that, in most instances, MDO outperforms other well-known techniques such as Particle Swarm Optimization (PSO), Differential Evolution (DE), Gravitational Search Algorithm (GSA) and Comprehensive Learning Particle Swarm Optimization(CLPSO) in terms of final convergence value and mean convergence value, thus proves to be a robust optimization technique.

FrE3-5 Real-World Applications II

Friday, July 11, 1:30PM-3:30PM, Room: 303, Chair: Isaac Triguero

1:30PM *Heuristic Optimization for Software Project Management with Impacts of Team Efficiency [#E-14632]*

Nanlin Jin and Xin Yao, Northumbria University, United Kingdom; University of Birmingham, United Kingdom

Most of the studies on project scheduling problems assume that every assigned participant or every team of the same number of participants, completes tasks with an equal efficiency, but this is usually not the case for real world problems. This paper presents a more realistic and complex model with extra considerations on team efficiency which are quantitatively measured on employee- task assignment. This study demonstrates the impacts of team efficiency in a well-studied software project management problem. Moreover, this study illustrates how a heuristic optimization method, population-based incremental learning, copes with such added complexity. The experimental results show that the resulting near optimal solutions not only satisfy constraints, but also reflect the impacts of team efficiency. The findings will hopefully motivate future studies on comprehensive understandings of the quality and efficiency of team work.

1:50PM *A Multiobjective Optimization Method Based on MOEA/D and Fuzzy Clustering for Change Detection in SAR Images [#E-14111]*

Qiao Wang, Hao Li, Maoguo Gong, Linzhi Su and Licheng Jiao, Xidian University, China

For the presence of speckle noise in SAR images, many change detection methods have been developed to suppress the effect of noise. However, all these methods will result in the loss of image details, and the trade-off between detail preserving and noise removing capability has become an urgent problem remaining to be settled. In this paper, we put forward an innovation for change detection in synthetic aperture radar images. It integrates evolutionary computation into fuzzy clustering process, and considers detail preserving capability and noise removing capability as two separate objectives for multiobjective optimization, and thus transforming the change detection problem into a multiobjective optimization problem (MOP).

Experiments conducted on real SAR images confirm that the new approach is efficient.

2:10PM *A Novel Evaluation Function for LT Codes Degree Distribution Optimization [#E-14772]*

Pei-Chuan Tsai, Chih-Ming Chen and Ying-ping Chen, National Chiao Tung University, Taiwan

Luby transform (LT) codes implements an important property called ratelessness, meaning a fixed code rate is unnecessary and LT codes can complete the transmission without channel status. The property is advantageous to transmit over certain environments such as broadcasting in heterogeneous networks or transmitting data over unknown channels. For this reason, improving LT codes is a crucial research issue in recent years. The performance of LT codes is decided by the code length and a probability mass function, called degree distribution, used in the encoding process. To improve the performance of LT codes, many studies proposed to optimize the degree distribution by using methods in evolutionary computation. One of the key steps in the evolutionary process is to evaluate decision variables for comparing the fitness of each individual. In the optimization of LT codes, it needs to repeatedly simulate the encoding/decoding process with a given distribution and evaluate the performance over a sufficient number of runs. Hence, a lot of computational resource is necessary for the optimization of LT codes. In this paper, we propose a heuristic function to evaluate the performance of LT codes. The evaluation function estimates the expected fraction of unsolved symbols with the specified code length, reception overhead, and degree distribution. Based on the proposed function, a huge number of evaluations is possible for searching for better degree distributions. We first verify the practicality of the proposed function and then employ it in a multi-objective evolutionary algorithm to investigate the trade-off of LT codes between the computational cost and decoding performance.

2:30PM *A Combined MapReduce-Windowing Two-Level Parallel Scheme for Evolutionary Prototype Generation [#E-14555]*

Isaac Triguero, Daniel Peralta, Jaume Bacardit, Salvador Garcia and Francisco Herrera, University of Granada, Spain; Newcastle University, United Kingdom; University of Jaen, Spain

Evolutionary prototype generation techniques have demonstrated their usefulness to improve the capabilities of the nearest neighbor classifier. They act as data reduction algorithms by generating representative points of a given problem. Their main purposes are to speed up the classification process and to reduce the storage requirements and sensitivity to noise of the nearest neighbor rule. Nowadays, with the increment of available data, the use of this kind of reduction techniques becomes more important. However, their applicability can be limited to problems with no more than tens of thousands of instances. In order to address this limitation, in this work we develop a two-level parallelization scheme for evolutionary prototype generation methods. Firstly, it distributes the functioning of these algorithms in several tasks based on a MapReduce framework. Then, for each one of these tasks (mappers), we accelerate the prototype generation process by using a windowing approach. This model enables evolutionary prototype generation algorithms to be applied over large-scale classification problems without accuracy loss. Our preliminary experiments using a dataset of 1 million instances show that this proposal is an appropriate tool to improve the performance of the nearest neighbor classifier with big data.

2:50PM *A Dynamic-Weighted Collaborative Filtering Approach to Address Sparsity and Adaptivity Issues [#E-14391]*

Liang Gu, Peng Yang and Yongqiang Dong, Southeast University, China

Recommendation systems, as efficient measures to handle the information overload and personalized service problems, have attracted considerable attention in research community. Collaborative filtering is one of the most successful techniques based on the user-item matrix in recommendation systems. Usually the matrix is extremely sparse due to the massive number of users and items. And the sparsity of users and items tends to differ significantly in degree. The feature of the matrix changes with the variation of users/items data and hence, leads to poor scalability of the recommendation method. This paper proposes a dynamic- weighted collaborative filtering approach (DWCF) to address sparsity and adaptivity issues. In this approach, the relationship between the distributions of similar users and items is considered to get better recommendation, i.e., the contributions of the user part and the item part to recommendation results depend on their similarity ratios. Moreover, the effect strength of different parts is controlled by an averaging parameter. Experiments on MovieLens dataset illustrate that the DWCF approach proposed in this paper can obtain good recommendation result given different conditions of data sparsity and perform better than a user-based predictor, an item-based predictor and a conventional hybrid approach.

3:10PM *Carry Trade Portfolio Optimization using Particle Swarm Optimization [#E-14569]*

Stuart Reid, Katherine Malan and Andries Engelbrecht, University of Pretoria, South Africa

Portfolio optimization has as its objective to find optimal portfolios, which apportion capital between their constituent assets such that the portfolio's risk adjusted return is maximized. Portfolio optimization becomes more complex as constraints are imposed, multiple sources of return are included, and alternative measures of risk are used. Meta-heuristic portfolio optimization can be used as an alternative to deterministic approaches under increased complexity conditions. This paper uses a particle swarm optimization (PSO) algorithm to optimize a diversified portfolio of carry trades. In a carry trade, investors profit by borrowing low interest rate currencies and lending high interest rate currencies, thereby generating return through the interest rate differential. However, carry trades are risky because of their exposure to foreign exchange losses. Previous studies showed that diversification does significantly mitigate this risk. This paper goes one step further and shows that meta-heuristic portfolio optimization can further improve the risk adjusted returns of diversified carry trade portfolios.

Friday, July 11, 4:00PM-6:00PM

FrE4-1 Constraint-Handling and Preference-Handling

Friday, July 11, 4:00PM-6:00PM, Room: 203A, Chair: Ruhul Sarker

4:00PM *On the Edge of Feasibility: A Case Study of the Particle Swarm Optimizer [#E-14260]*

Mohammad reza Bonyadi and Zbigniew Michalewicz, The University of Adelaide, Australia

In many real-world constrained optimization problems (COPs) it is highly probable that some constraints are active at optimum points, i.e. some optimum points are boundary points between feasible and infeasible parts of the search space. A method is proposed which narrows the feasible area of a COP to its boundary. In the proposed method the thickness of the narrowed boundary is adjustable by a parameter. The method is extended in a way that it is able to limit the feasible regions to boundaries where at least one of the constraints in a given subset of all constraints is active and the remaining constraints might be active or not. Another extension is able to limit the search to cases where all constraints in a given subset are active and the rest might be active or not. The particle swarm optimization algorithm is used

as a framework to compare the proposed methods. Results show that the proposed methods can limit the search to the requested boundary and they are effective in locating optimal solutions on the boundaries of the feasible and infeasible area.

4:20PM *Linear Sparse Arrays Designed by Dynamic Constrained Multi-Objective Evolutionary Algorithm [#E-14469]*

Wei Dong and Sanyou Zeng, China University of Geosciences, China

The design of linear sparse array is a constrained multi-objective optimization problem(CMOP). There are three objectives: minimization of peak sidelobe level (PSLL), half-power beam width(HPBW) and spatial aperture. And the amplitude coefficients of elements and the sensor positions of the array are decision variables. Dynamic constrained multi-objective evolutionary algorithm(DCMOEA) is used to design linear sparse arrays in this paper. It makes a difference that the output is a set of Pareto solutions (antenna arrays), not just only one solution. The users can choose an array from the set to meet their preferences for low PSLL, small HPBW, small spatial aperture or a trade-off among them. Experimental results showed that the DCMOEA performs better than peer state-of-art algorithms referred in this paper, especially on the arrays' spatial aperture optimization.

4:40PM *Mapping Constrained Optimization Problems to Penalty Parameters: An Empirical Study [#E-14323]*

Chengyong Si, Jianqiang Shen, Xuan Zou, Lei Wang and Qidi Wu, University of Shanghai for Science and Technology, China; Tongji University, China; Tongji University, China

Penalty function method is one of the most popular used Constraint Handling Technique for Evolutionary Algorithms (EAs) solution selecting, whose performance is mainly determined by penalty parameters. This paper tries to study the penalty parameter from the aspect of problem characteristics, i.e., to construct a corresponding relationship between the problems and the penalty parameters. The experimental results confirm the relationship, which provides valuable reference for future algorithm design.

5:00PM *A Constrained Multi-Objective Surrogate-Based Optimization Algorithm [#E-14722]*

Prashant Singh, Ivo Couckuyt, Francesco Ferranti and Tom Dhaene, Ghent University, Belgium

Surrogate models or metamodels are widely used in the realm of engineering for design optimization to minimize the number of computationally expensive simulations. Most practical problems often have conflicting objectives, which lead to a number of competing solutions which form a Pareto front. Multi-objective surrogate-based constrained optimization algorithms have been proposed in literature, but handling constraints directly is a relatively new research area. Most algorithms proposed to directly deal with multi-objective optimization have been evolutionary algorithms (Multi-Objective Evolutionary Algorithms - MOEAs). MOEAs can handle large design spaces but require a large number of simulations, which might be infeasible in practice, especially if the constraints are expensive. A multi-objective constrained optimization algorithm is presented in this paper which makes use of Kriging models, in conjunction with multi-objective probability of improvement (PoI) and probability of feasibility (PoF) criteria to drive the sample selection process economically. The efficacy of the pro- posed algorithm is demonstrated on an analytical benchmark function, and the algorithm is then used to solve a microwave filter design optimization problem.

5:20PM *A Feature-Based Analysis on the Impact of Linear Constraints for e-Constrained Differential Evolution [#E-14709]*

Shayan Poursoltan and Frank Neumann, University of Adelaide, Australia

Feature-based analysis has provided new insights into what characteristics make a problem hard or easy for a given algorithms. Studies, so far, considered unconstrained continuous optimisation problem and classical combinatorial optimisation problems such as the Travelling Salesperson problem. In this paper, we present a first feature-based analysis for constrained continuous optimisation. To start the feature-based analysis of constrained continuous optimization, we examine how linear constraints can influence the optimisation behaviour of the well-known e-constrained differential evolution algorithm. Evolving the coefficients of a linear constraint, we show that even the type of one linear constraint can make a difference of 10-30% in terms of function evaluations for well-known continuous benchmark functions.

5:40PM *DMOPSO: Dual Multi-Objective Particle Swarm Optimization [#E-14512]*

Lee Ki-Baek and Kim Jong-Hwan, Korea Advanced Institute of Science and Technology, Korea (South)

Since multi-objective optimization algorithms (MOEAs) have to find exponentially increasing number of nondominated solutions with the increasing number of objectives, it is necessary to discriminate more meaningful ones from the other nondominated solutions by additionally incorporating user preference into the algorithms. This paper proposes dual multi-objective particle swarm optimization (DMOSPO) by introducing secondary objectives of maximizing both user preference and diversity to the nondominated solutions obtained for primary objectives. The proposed DMOSPO can induce the balanced exploration of the particles in terms of user preference and diversity through the dual-stage of nondominated sorting such that it can generate preferable and diverse nondominated solutions. To demonstrate the effectiveness of the proposed DMOPSO, empirical comparisons with other state-of-the-art algorithms are carried out for benchmark functions. Experimental results show that DMOPSO is competitive with the other compared algorithms and properly reflects the user's preference in the optimization process while maintaining the diversity and solution quality.

FrE4-2 Particle Swarm Optimization

Friday, July 11, 4:00PM-6:00PM, Room: 203B, Chair: Kazuaki Masuda

4:00PM *Demonstrator Selection in a Social Learning Particle Swarm Optimizer [#E-14017]*

Ran Cheng and Yaochu Jin, University of Surrey, United Kingdom

Social learning plays an important role in behavior learning among social animals. Different from individual (asocial) learning, social learning has the advantage of allowing individuals to learn behaviors from others without the extra costs of individual trial-and-error. Inspired by the natural social learning phenomenon, we have transplanted the social learning mechanism into particle swarm optimization (PSO) to develop a social learning PSO (SL-PSO). Unlike classical PSO variants, the SL-PSO is performed on a sorted swarm, and instead of merely learning from historical best positions, the particles are able to learn from anyone better (demonstrators) in the current swarm. A key mechanism in the SL-PSO is the learning strategy, where an imitator will learn from different demonstrators. However, in our previous work, little discussion has been focused on demonstrator selection, i.e., which demonstrators are to learn from by the imitator. In this paper, based on the analysis of the demonstrator selection in the SL-PSO, two demonstrator selection strategies are proposed. Experimental results show that, the proposed demonstrator selection strategies have significantly enhanced the performance of the SL-PSO in comparison to five representative PSO variants on a set of benchmark problems.

4:20PM *Filter Based Backward Elimination in Wrapper Based PSO for Feature Selection in Classification [#E-14863]*

Bach Hoai Nguyen, Bing Xue, Ivy Liu and Mengjie Zhang, Victoria University of Wellington, New Zealand

The advances in data collection increase the dimensionality of the data (i.e. the total number of features) in many fields, which arises a challenge to many existing feature selection approaches. This paper develops a new feature selection approach based on particle swarm optimisation (PSO) and a local search that mimics the typical backward elimination feature selection method. The proposed algorithm uses a wrapper based fitness function, i.e. the classification error rate. The local search is performed only on the global best and uses a filter based measure, which aims to take the advantages of both filter and wrapper approaches. The proposed approach is tested and compared with three recent PSO based feature selection algorithms and two typical traditional feature selection methods. Experiments on eight benchmark datasets show that the proposed algorithm can be successfully used to select a significantly smaller number of features and simultaneously improve the classification performance over using all features. The proposed approach outperforms the three PSO based algorithms and the two traditional methods.

4:40PM *An Archive Based Particle Swarm Optimisation for Feature Selection in Classification [#E-14525]*

Bing Xue, A. K. Qin and Mengjie Zhang, Victoria University of Wellington, New Zealand; RMIT University, Australia

Feature selection aims to select a subset of relevant features from typically a large number of original features, which is a difficult task due to the large search space. Particle swarm optimisation (PSO) is a powerful search technique, but there are some limitations on using the standard PSO for feature selection. This paper proposes a new PSO based feature selection approach, which introduces an external archive to store promising solutions obtained during the search process. The solutions in the archive serve as potential leaders (i.e. global best, gbest) to guide the swarm to search for an optimal feature subset with the lowest classification error rate and a smaller number of features. The proposed approach has two specific methods, PSOArR and PSOArRWS, where PSOArR randomly selects gbest from the archive and PSOArRWS uses the roulette wheel selection to select gbest considering both the classification error rate and also considering the number of selected features. Experiments on twelve benchmark datasets show that both PSOArR and PSOArRWS can successfully select a smaller number of features and achieve similar or better classification performance than using all features. PSOArR and PSOArRWS outperform a PSO based algorithm without using an archive and two traditional feature selection methods. The performance of PSOArR and PSOArRWS are similar to each other.

5:00PM *A Graph-Based Particle Swarm Optimisation Approach to QoS-Aware Web Service Composition and Selection [#E-14392]*

Alexandre Sawczuk da Silva, Hui Ma and Mengjie Zhang, Victoria University of Wellington, New Zealand

Web services are network-accessible modules that perform specific tasks and can be integrated into Web service compositions to accomplish more complex objectives. Due to the fast-growing number of Web services and the well-defined nature of their interfaces, the field of automated Web service composition is quickly expanding. The use of Particle Swarm Optimisation composition techniques that take Quality of Service (QoS) properties into account is well-established in the field. However, the commonly utilised approach is to optimise a preselected Web service composition workflow, which requires domain expertise and prior knowledge and thus may lead to the loss of better solutions that require different workflow configurations. This paper presents a graph-based PSO technique which simultaneously determines an optimal workflow and near-optimal Web services to be included in the composition based on their QoS properties, as well as a greedy-based PSO technique which follows the commonly utilised approach. The comparison of the two techniques shows that despite requiring more execution time, the graph-based approach provides equivalent or better solutions than the greedy-based approach, depending on the workflow preselected by the greedy-based PSO. These results demonstrate that under certain circumstances, the graph-based approach is capable of producing solutions whose fitness surpasses that of the solutions obtained by employing the greedy-based approach.

5:20PM *Task Allocation Under Communication Constraints Using Motivated Particle Swarm Optimization [#E-14693]*

Medria Hardhienata, Valery Ugrinovskii and Kathryn Merrick, University of New South Wales, Australia

This paper considers task allocation problems where a group of agents must discover and allocate themselves to tasks. Task allocation is particularly difficult when agents can only exchange information over a limited communication range and when the agents are initialized from a single departure point. To address these constraints, we present a novel approach that incorporates computational models of motivation into a guaranteed convergence particle swarm optimization algorithm. We introduce an incentive function and three motive profiles to guaranteed convergence particle swarm optimization. Our new algorithm is compared to existing approaches with and without motivation under conditions of limited communication. It is tested in the case where the agents are initialized from a single point and random points. Results show that our approach increases the number of tasks discovered by a group of agents under these conditions. Furthermore, it significantly outperforms benchmark PSO algorithms in the number of tasks discovered and allocated when the agents are initialized from a single point.

5:40PM *Serial PSO Results are Irrelevant in a Multi-Core Parallel World [#E-14012]*

Andrew McNabb and Kevin Seppi, Brigham Young University, United States

From multi-core processors to parallel GPUs to computing clusters, computing resources are increasingly parallel. These parallel resources are being used to address increasingly challenging applications. This presents an opportunity to design optimization algorithms that use parallel processors efficiently. In spite of the intuitively parallel nature of Particle Swarm Optimization (PSO), many PSO variants are not evaluated from a parallel perspective and introduce extra communication and bottlenecks that are inefficient in a parallel environment. We argue that the standard practice of evaluating a PSO variant by reporting function values with respect to the number of function evaluations is inadequate for evaluating PSO in a parallel environment. Evaluating the parallel performance of a PSO variant instead requires reporting function values with respect to the number of iterations to show how the algorithm scales with the number of processors, along with an implementation-independent description of task interactions and communication. Furthermore, it is important to acknowledge the dependence of performance on specific properties of the objective function and computational resources. We discuss parallel evaluation of PSO, and we review approaches for increasing concurrency and for reducing communication which should be considered when discussing the scalability of a PSO variant. This discussion is essential both for designers who are defending the performance of an algorithm and for practitioners who are determining how to apply PSO for a given objective function and parallel environment.

Special Session: FrE4-3 Dynamic Multi-Objective Optimization

Friday, July 11, 4:00PM-6:00PM, Room: 203C, Chair: Marde Helbig

4:00PM *Heterogeneous Dynamic Vector Evaluated Particle Swarm Optimisation for Dynamic Multi-Objective Optimisation [#E-14186]*

Marde Helbig and Andries Engelbrecht, CSIR: Meraka Institute and University of Pretoria, South Africa; University of Pretoria, South Africa

Optimisation problems with more than one objective, where at least one objective changes over time, are called dynamic multi-objective optimisation problems (DMOOPs). Since at least two objectives are in conflict with one another, a single solution does not exist, and therefore the goal of a dynamic multi- objective optimisation algorithm (DMOA) is to track the set of optimal trade-off solutions over time. One of the major issues when solving optimisation problems, is balancing exploration and exploitation during the search process. This paper investigates the performance of the dynamic vector evaluated particle swarm optimisation (DVEPSO) algorithm using heterogeneous PSOs (HPSOs), where each particle has a different behaviour. The goal of the study is to determine whether the use of heterogeneous particle swarm optimisation (HPSO) algorithms will improve the performance of DVEPSO by incorporating particles with exploration and exploitation behaviour in a single particle swarm optimisation (PSO) algorithm. The results indicate that using HPSOs improves the performance of DVEPSO, especially for type I and type III DMOOPs.

4:20PM *An Adaptive Diversity Introduction Method for Dynamic Evolutionary Multiobjective Optimization [#E-14309]*

Min Liu, Jinhua Zheng, Junnian Wang, Yuzhen Liu and Lei Jiang, Hunan University of Science and Technology, China; Xiangtan University, China

This paper investigates how to use diversity introduction methods to enhance the dynamic evolutionary multiobjective optimization algorithms in dealing with dynamic multiobjective optimization problems (DMOPs). Although diversity introduction method is easy used to response to the dynamic change, current diversity introduction methods still have a difficulty in identifying the correct proportion of diversity introduction. To overcome this difficulty, this paper proposes an adaptive diversity introduction (ADI) method. Specifically, the proportion of diversity introduction can be dynamically adjusted rather than being hand designed and fixed in advance. In addition, an adaptive relocation operator is designed to adapt the evolving individuals to the new environmental condition. The effectiveness of the ADI method is validated against various diversity introduction methods upon five DMOPs test problems. The simulation results show that the proposed ADI has better robustness and total performance than other diversity introduction methods.

4:40PM *A Multiple Reference Point-Based Evolutionary Algorithm for Dynamic Multi-Objective Optimization with Undetectable Changes [#E-14705]*

Radhia Azzouz, Slim Bechikh and Lamjed Ben Said, University of Tunis, Tunisia

Dynamic multi-objective optimization problems involve the simultaneous optimization of several competing objectives where the objective functions and/or constraints may change over time. Evolutionary algorithms have been considered as popular approaches to solve such problems. Despite the considerable number of studies reported in evolutionary optimization in dynamic environments, most of them are restricted to the single objective case. Moreover, the majority of dynamic multi-objective optimization algorithms are based on the use of some techniques to detect or predict changes which is sometimes difficult or even impossible. In this work, we address the problem of dynamic multi-objective optimization with undetectable changes. To achieve this task, we propose a new algorithm called Multiple Reference Point-based Multi- Objective Evolutionary Algorithm (MRP-MOEA) which does not need to detect changes. Our algorithm uses a new reference point-based dominance relation ensuring the guidance of the search towards the Pareto optimal front. The performance of our proposed method is assessed using various benchmark problems. Furthermore, the comparative experiments show that MRP-MOEA outperforms serveral dynamic multi-objective optimization algorithms not only in tracking the Pareto front but also in maintainig diversity over time albeit the changes are undetectable.

5:00PM *Artificial Bee Colony Induced Multi-Objective Optimization in Presence of Noise [#E-14620]*

Pratyusha Rakshit, Amit Konar and Atulya Nagar, Jadavpur University, India; Liverpool hope University, United Kingdom

The paper aims at designing new strategies to extend traditional Non-dominated Sorting Bee Colony algorithm to proficiently obtain Pareto-optimal solutions in presence of noise on the fitness landscapes. The first strategy, referred to as adaptive selection of sample-size, is employed to balance the trade-off between accurate fitness estimate and computational complexity. The second strategy is concerned with determining statistical expectation, instead of conventional averaging of fitness-samples as the measure of fitness of the trial solutions. The third strategy attempts to extend Goldberg's approach to examine possible placement of a slightly inferior solution in the optimal Pareto front using a more statistically viable comparator. Experiments undertaken to study the performance of the extended algorithm reveal that the extended algorithm outperforms its competitors with respect to four performance metrics, when examined on a test-suite of 23 standard benchmarks with additive noise of three statistical distributions.

5:20PM *A Cascaded Evolutionary Multi-Objective Optimization for Solving the Unbiased Universal Electric Motor Family Problem [#E-14766]*

Timo Friedrich and Stefan Menzel, Honda Research Institute Europe, Germany

For a successful business model the efficient development and design of a comprehensive product family plays a crucial part in many real world applications. A product family as it occurs, e.g., in the automotive domain consists of a product platform which covers the commonalities of product variants and the derived product variants. While product variants need to be fast and flexibly adjusted to market needs, from manufacturing and development point of view an underlying product platform with a large number of common parts is required to increase cost efficiency. For the design and evaluation of optimization methods for product family development, in the present paper the universal electric motor (UEM) family problem is considered, as it provides a fair trade-off between complexity and computational costs compared to real world application scenarios in the automotive domain. Since especially solving this problem without usage of pre- knowledge comes with high computational costs, a cascaded evolutionary multi- objective optimization based on NSGA-II with concatenation of product Pareto fronts is proposed in the present paper to efficiently reduce computational time. Besides providing sets of Pareto solutions to the unbiased UEM family problem the effects of considering solutions of prior platform optimizations as starting point for follow-up optimizations under changing requirements are evaluated.

5:40PM *Evolutionary Multiobjective Optimization in Dynamic Environments: A Set of Novel Benchmark Functions [#E-14548]*

Subhodip Biswas, Swagatam Das, Ponnuthurai Nagaratnam Suganthan and Carlos A. Coello Coello, Jadavpur University, India; Indian Statistical Institute, India; Nanyang Technological University, Singapore; CINVESTAV-IPN, Mexico

Time varying nature of the constraints, objectives and parameters characterize several practical optimization problems. This fact leads us to the field of dynamic optimization with Evolutionary Algorithms (EAs). In recent past, a significant amount of research has been devoted to single-objective dynamic optimization problems. Very few researchers have, however, concentrated their efforts on the study of Dynamic multiobjective Optimization Problems (DMOPs) where the dynamicity is attributed to multiple objectives of conflicting nature. Considering the lack of a somewhat diverse and

challenging set of benchmark functions, in this article we discuss some techniques to design dynamic multiobjective problems. We propose some general techniques for introducing dynamicity in the Pareto Set and in the Pareto Front through shifting, shape variation, slope variation, phase variation, and several other types. We introduce nine benchmark functions, which have been derived from the benchmark suite used for the competition on bound-constrained and static multiobjective optimization algorithms, held under the 2009 IEEE Congress on Evolutionary Computation (CEC).

Special Session: FrE4-4 Fireworks Algorithms for Optimization

Friday, July 11, 4:00PM-6:00PM, Room: 203D, Chair: Ying Tan

4:00PM *A Hybrid Biogeography-Based Optimization and Fireworks Algorithm [#E-14151]*

Bei Zhang, Min-Xia Zhang and Yu-Jun Zheng, Zhejiang University of Technology, China

The paper presents a hybrid biogeography-based optimization (BBO) and fireworks algorithm (FWA) for global optimization. The key idea is to introduce the migration operator of BBO to FWA, in order to enhance information sharing among the population, and thus improve solution diversity and avoid premature convergence. A migration probability is designed to integrate the migration of BBO and the normal explosion operator of FWA, which can not only reduce the computational burden, but also achieve a better balance between solution diversification and intensification. The Gaussian explosion of the enhanced FWA (EFWA) is reserved to keep the high exploration ability of the algorithm. Experimental results on selected benchmark functions show that the hybrid BBO_FWA has a significantly performance improvement in comparison with both BBO and EFWA.

4:20PM *Analysis on Global Convergence and Time Complexity of Fireworks Algorithm [#E-14858]*

Jianhua Liu, Shaoqiu Zheng and Ying Tan, Fujian University of Technology, China; Peking University, China

Fireworks Algorithm (FWA) is a new proposed optimization technique based on swarm intelligence. In FWA, the algorithm generates the explosion sparks and Gaussian mutation sparks by the explosion operator and Gaussian mutation operator to search the global optimum in the problem space. FWA has been applied in various fields of practical optimization problems and gains great success. However, its convergence property has not been analyzed since it has been provided. Same as other swarm intelligence (SI) algorithms, the optimization process of FWA is able to be considered as a Markov process. In this paper, a Markov stochastic process on FWA has been defined, and is used to prove the global convergence of FWA while analyzing its time complexity. In addition, the computation of the approximation region of expected convergence time of FWA has also been given.

4:40PM *Adaptive Fireworks Algorithm [#E-14415]*

Junzhi Li, Shaoqiu Zheng and Ying Tan, Peking University, China

In this paper, firstly, the amplitude used in the Enhanced Fireworks Algorithm (EFWA) is analyzed and its lack of adaptability is revealed, and then the adaptive amplitude method is proposed where amplitude is calculated according to the already evaluated fitness of the individuals adaptively. Finally, the Adaptive Fireworks Algorithm (AFWA) is proposed, replacing the amplitude operator in EFWA with the new adaptive amplitude. Some theoretical analyses are made to prove the adaptive explosion amplitude a promising method. Experiments on CEC13's 28 benchmark functions are also conducted in order to illustrate the performance and it turns out that the AFWA where adaptive amplitude is adopted outperforms significantly the EFWA and meanwhile the time consumed is not longer. Moreover, according to experimental results, AFWA performs better than the Standard Particle Swarm Optimization (SPSO).

5:00PM *Dynamic Search in Fireworks Algorithm [#E-14544]*

Shaoqiu Zheng, Andreas Janecek, Junzhi Li and Ying Tan, Peking University, China; University of Vienna, Austria

We propose an improved version of the recently developed Enhanced Fireworks Algorithm (EFWA) based on an adaptive dynamic local search mechanism. In EFWA, the explosion amplitude (i.e., search area around the current location) of each firework is computed based on the quality of the firework's current location. This explosion amplitude is limited by a lower bound which decreases with the number of iterations in order to avoid the explosion amplitude to be [close to] zero, and in order to enhance global search abilities at the beginning and local search abilities towards the later phase of the algorithm. As the explosion amplitude in EFWA depends solely on the fireworks' fitness and the current number of iterations, this procedure does not allow for an adaptive optimization process. To deal with these limitations, we propose the Dynamic Search Fireworks Algorithm (dynFWA) which uses a dynamic explosion amplitude for the firework at the currently best position. If the fitness of the best firework could be improved, the explosion amplitude will increase in order to speed up convergence. On the contrary, if the current position of the best firework could not be improved,the explosion amplitude will decrease in order to narrow the search area. In addition, we show that one of the EFWA operators can be removed in dynFWA without a loss in accuracy---this makes dynFWA computationally more efficient than EFWA. Experiments on 28 benchmark functions indicate that dynFWA is able to significantly outperform EFWA, and achieves better performance than the latest SPSO version SPSO2011.

5:20PM *Maintaining Population Diversity in Brain Storm Optimization Algorithm [#E-14081]*

Shi Cheng, Yuhui Shi, Quande Qin, T. O. Ting and Ruibin Bai, The University of Nottingham Ningbo, China; Xi'an Jiaotong-Liverpool University, China; Shenzhen University, China

Swarm intelligence suffers the premature convergence, which happens partially due to the solutions getting clustered together, and not diverging again. The brain storm optimization (BSO), which is a young and promising algorithm in swarm intelligence, is based on the collective behavior of human being, that is, the brainstorming process. Premature convergence also happens in the BSO algorithm. The solutions get clustered after a few iterations, which indicate that the population diversity decreases quickly during the search. A definition of population diversity in BSO algorithm to measure the change of solutions' distribution is proposed in this paper. The algorithm's exploration and exploitation ability can be measured based on the change of population diversity. Two kinds of partial re-initialization strategies are utilized to improve the population diversity in BSO algorithm. The experimental results show that the performance of the BSO is improved by these two strategies.

5:40PM *Fireworks Algorithm with Differential Mutation for Solving the CEC 2014 Competition Problems [#E-14740]*

Chao Yu, Lingchen Kelley, Shaoqiu Zheng and Ying Tan, Peking University, China; Tsinghua University, China

The idea of fireworks algorithm (FWA) is inspired by the fireworks explosion in the sky at night. When a firework explodes, a shower of sparks appear

around it. In this way, the adjacent area of the firework is searched. By controlling the amplitude of the explosion, the ability of local search for FWA is guaranteed. The way of fireworks algorithm searching the surrounding area can be further improved by differential mutation operator, forming an algorithm called FWA-DM. In this paper, the benchmark suite in the competition of congress of evolutionary computation (CEC) 2014 is used to test the performance of FWA- DM.

FrE4-5 Real-World Applications III

Friday, July 11, 4:00PM-6:00PM, Room: 303, Chair: David Camacho

4:00PM *Evolutionary Algorithms Dynamics and Its Hidden Complex Network Structures [#E-14459]*

Zelinka Ivan, Lampinen Jouni, Senkerik Roman, Pluhacek Michal and Davendra Donald, VSB-Technical University of Ostrava, Czech Republic; University of Vaasa, Finland; Tomas Bata University, Czech Republic

In this participation, we are continuing to show mutual intersection of two completely different areas of research: complex networks and evolutionary computation. Large-scale networks, exhibiting complex patterns of interaction amongst vertices exist in both nature and in man-made systems (i.e., communication networks, genetic pathways, ecological or economical networks, social networks, networks of various scientific collaboration etc. and are a part of our daily life. We are demonstrating that dynamics of evolutionary algorithms, that are based on Darwin theory of evolution and Mendel theory of genetic heritage, can be also visualized as a complex networks. Such network can be then analyzed by means of classical tools of complex networks science. Results presented here are at the moment numerical demonstration rather than theoretical mathematical proofs. We open question whether evolutionary algorithms really create complex network structures and whether this knowledge can be successfully used like feedback for control of evolutionary dynamics and its improvement in order to increase the performance of evolutionary algorithms.

4:20PM *Knowledge Acquisition Issues for Intelligent Route Optimization by Evolutionary Computation [#E-14410]*

Masaki Suzuki, Setsuo Tsuruta, Rainer Knauf and Yoshitaka Sakurai, Tokyo Denki University, Japan; Ilmenau University of Technology, Germany; Meiji University, Japan

The paper introduces a Knowledge Acquisition and Maintenance concept for a Case Based Approximation method to solve large scale Traveling Salesman Problems in a short time (around 3 seconds) with an error rate below 3%. This method is based on the insight, that most solutions are very similar to solutions that have been created before. Thus, in many cases a solution can be derived from former solutions by (1) selecting a most similar TSP from a library of former TSP solutions, (2) removing the locations that are not part of the current TSP and (3) adding the missing locations of the current TSP by mutation, namely Nearest Insertion (NI). This way of creating solutions by Case Based Reasoning (CBR) avoids the computational costs to create new solutions from scratch.

4:40PM *A Memetic Algorithm for the Prize Collecting Traveling Car Renter Problem [#E-14252]*

Matheus Menezes, Marco Goldbarg and Elizabeth Goldbarg, Universidade Federal Rural do Semi Arido, Brazil; Universidade Federal do Rio Grande do Norte, Brazil

This paper introduces a new variant of the Traveling Car Renter Problem, named Prize-collecting Traveling Car Renter Problem. In this problem, a set of vertices, each associated with a bonus, and a set of vehicles are given. The bonus represents a degree of satisfaction to visit the vertex. The objective is to determine a cycle that visits some vertices collecting, at least, a pre-defined bonus, i.e. reaching a pre-specified satisfaction, and minimizing the cost of the tour that can be traveled with different vehicles. A mathematical formulation is presented and implemented in a solver to produce results for sixty-four instances. A memetic algorithm is proposed and its performance is evaluated in comparison to the results obtained with the solver.

5:00PM *Network on Chip Optimization Based on Surrogate Model Assisted Evolutionary Algorithms [#E-14689]*

Mengyuan Wu, Ammar Karkar, Bo Liu, Alex Yakovlev and Georges Gielen, Katholieke Universiteit Leuven, Belgium; Newcastle University, United Kingdom; Glyndwr University, United Kingdom

Network-on-Chip (NoC) design is attracting more and more attention nowadays, but there is a lack of design optimization method due to the computationally very expensive simulations of NoC. To address this problem, an algorithm, called NoC design optimization based on Gaussian process model assisted differential evolution (NDPAD), is presented. Using the surrogate model-aware evolutionary search (SMAS) framework with the tournament selection based constraint handling method, NDPAD can obtain satisfactory solutions using a limited number of expensive simulations. The evolutionary search strategies and training data selection methods are then investigated to handle integer design parameters in NoC design optimization problems. Comparison shows that comparable or even better design solutions can be obtained compared to standard EAs, and much less computation effort is needed.

5:20PM *A Genetic Algorithm for the Minimum Latency Pickup and Delivery Problem [#E-14809]*

Xin-Lan Liao, Chih-Hung Chien and Chuan-Kang Ting, National Chung Cheng University, Taiwan

The pickup and delivery problem combines vehicle routing and objects distribution to cope with logistic problems. While most research on PDP aims to minimize the transportation cost for the sake of service providers, this study proposes the minimum latency pickup and delivery problem (MLPDP) that seeks a low-latency route to transport commodities among nodes, where latency represents the sum of transportation time between demanders and the corresponding suppliers. The MLPDP is pertinent to time-sensitive services and logistics focusing on customer satisfaction. This study defines the latency of a customer as the average time elapsed aboard of goods received. The last-in- first-out loading method is employed to simulate real-world rear-loaded vehicles. This study further designs a genetic algorithm (GA) to resolve the MLPDP. In particular, we propose the edge aggregate crossover (EAC) and the reversely weighting technique to improve the performance of GA on the MLPDP. Experimental results show the effectiveness of the proposed GA. The results further indicate that EAC leads to significantly better performance than conventional crossover operators in solution quality and convergence speed on the MLPDP.

5:40PM *A Heuristic Approach to Greener Airport Ground Movement [#E-14325]*

Michal Weiszer, Jun Chen, Stefan Ravizza, Jason Atkin and Paul Stewart, University of Lincoln, United Kingdom; IBM Global Business Services, Switzerland; University of Nottingham, United Kingdom; University of Hull, United Kingdom

Ever increasing air traffic, rising costs and tighter environmental targets create a pressure for efficient airport ground movement. Ground movement

links other airport operations such as departure sequencing, arrival sequencing and gate/stand allocation and its operation can affect each of these. Previously, reducing taxi time was considered the main objective of the ground movement problem. However, this may conflict with efforts of airlines to minimise their fuel consumption as shorter taxi time may require higher speed and acceleration during taxiing. Therefore, in this paper a multi-objective multi-component optimisation problem is formulated which combines two components: scheduling and routing of aircraft and speed profile optimisation. To solve this problem an integrated solution method is adopted to more accurately investigate the trade- off between the total taxi time and fuel consumption. The new heuristic which is proposed here uses observations about the characteristics of the optimised speed profiles in order to greatly improve the speed of the graph-based routing and scheduling algorithm. Current results, using real airport data, confirm that this approach can find better solutions faster, making it very promising for application within on-line applications.

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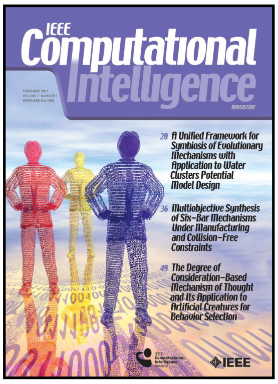

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* Features 30+ Keynote/Invited Talks by world renowned researchers;
* Offers an exciting Doctoral Consortium for young researchers and students;
* Provides numerous travel grants to support attending the conference;

The IEEE SSCI 2014 is proud to feature the following Symposia:

ADPRL'14:	IEEE Symposium on Adaptive Dynamic Programming and Reinforcement Learning;
CCMB'14:	IEEE Symposium on Computational Intelligence, Cognitive Algorithms, Mind, and Brain;
CIASG'14:	IEEE Symposium on Computational Intelligence Applications in Smart Grid;
CIBCI'14:	IEEE Symposium on Computational Intelligence in Brain Computer Interfaces;
CIBD'14:	IEEE Symposium on Computational Intelligence in Big Data;
CIBIM'14:	IEEE Symposium on Computational Intelligence in Biometrics and Identity Management;
CICA'14:	IEEE Symposium on Computational Intelligence in Control and Automation;
CICARE'14:	IEEE Symposium on Computational Intelligence in healthcare and e-health;
CIComms'14:	IEEE Symposium on Computational Intelligence for Communication Systems and Networks;
CICS'14:	IEEE Symposium on Computational Intelligence in Cyber Security;
CIDM'14:	IEEE Symposium on Computational Intelligence and Data Mining;
CIDUE'14:	IEEE Symposium on Computational Intelligence in Dynamic and Uncertain Environments,
CIEL'14:	IEEE Symposium on Computational Intelligence in Ensemble Learning
CIES'14:	IEEE Symposium on Computational Intelligence for Engineering Solutions;
CIHLI'14:	IEEE Symposium on Computational Intelligence for Human-like Intelligence;
CIMSIVP'14:	IEEE Symposium on Computational Intelligence for Multimedia, Signal and Vision Processing;
CIPLS'14:	IEEE Symposium on Computational Intelligence in Production and Logistics Systems;
CIVTS'14:	IEEE Symposium on Computational Intelligence in Vehicles and Transportation Systems;
EALS'14:	IEEE Symposium on Evolving and Autonomous Learning Systems;
FOCI'14:	IEEE Symposium on Foundations of Computational Intelligence;
IA'14:	IEEE Symposium on Intelligent Agents;
IES'14:	IEEE Symposium on Intelligent Embedded Systems;
ICES'14:	IEEE International Conference on Evolvable Systems;
ISIC'14:	IEEE International Symposium on Independent Computing;
CIR2AT'14:	IEEE Symposium on Computational Intelligence in Robotic Rehabilitation and Assistive Technologies;
MC'14:	IEEE Workshop on Memetic Computing;
MCDM'14:	IEEE Symposium on Computational Intelligence in Multicriteria Decision-Making;
RiiSS'14:	IEEE Workshop on Robotic Intelligence in Informationally Structured Space;
SDE'14:	IEEE Symposium on Differential Evolution;
SIS'14:	IEEE Symposium on Swarm Intelligence;

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The **2015 International Joint Conference on Neural Networks** will be held at the Killarney Convention Centre in Killarney, Ireland, July 12–16, 2015. The conference is organized jointly by the **International Neural Network Society** and the **IEEE Computational Intelligence Society**, and is the premiere international meeting for researchers and other professionals in neural networks and related areas.

The range of topics covered include, but is not limited to the following.
(See `http://ijcnn.org/2015` for a more detailed list of topics).

- Neural network theory & models
- Computational neuroscience
- Cognitive models
- Brain-machine interfaces
- Embodied robotics
- Evolutionary neural systems
- Neurodynamics
- Neuroinformatics
- Neuroengineering
- Hardware, memristors
- Neural network applications
- Machine vision
- Big data
- Pattern recognition
- Machine learning
- Collective intelligence
- Hybrid systems
- Self-aware systems
- Data mining
- Sensor networks
- Agent-based systems
- Computational biology
- Bioinformatics
- Artificial life
- Connectomics
- Deep learning

The conference will feature:

- Contributed technical talks and posters of latest research from around the world.
- Plenary lecturers by world-famous researchers in neural networks and related fields.
- Special sessions covering topics of active current interest.
- Pre-conference tutorials and post-conference workshops with presentations by experts.
- Challenging competitions on applying neural networks to hard computational problems.

Important Dates:

Special session & competition proposals submission:	November 10, 2014
Tutorial and workshop proposal submission:	December 15, 2014
Paper submission:	January 15, 2015
Paper decision notification:	March 15, 2015
Camera-ready submission:	April 15, 2015

Sponsored by International Neural Network Society · IEEE Computational Intelligence Society

Photo credit: Killarney Convention Center (edited to fit space); Logo made with `knotter`.

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2015 IEEE International Conference on Fuzzy Systems

August 2-5, 2015, Istanbul, TURKEY

Venue

The 2015 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE 2015), one of the leading international conferences in the field of fuzzy sets and systems, will be held in Istanbul, Turkey. Istanbul is the largest city of Turkey and the third largest city in the world. The city is located on the Bosphorus Strait and encompasses the natural harbor known as the Golden Horn. It extends both on the European (Thrace) and on the Asian (Anatolia) sides of the Bosphorus, and is thereby the only metropolis in the world which is situated on two continents.

Scope:

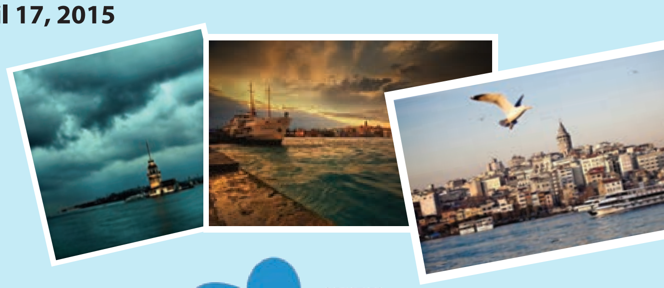
The conference will provide a platform for researchers and practitioners to interact with one another and discuss the state-of-the-art developments in the field. The topics of the conference will cover all aspects of theories and applications in fuzzy systems and soft computing, including but not limited to:

Fuzzy control, robotics, sensors, fuzzy hardware and architectures
Fuzzy systems, design, decision analysis and decision support
Fuzzy modeling, identification and fault detection
Fuzzy data analysis, fuzzy clustering, classification and pattern recognition
Fuzzy information processing, information extraction and fusion
Fuzzy web engineering, information retrieval and text mining
Knowledge discovery, learning, reasoning and knowledge representation
Type-2 fuzzy sets, computing with words and granular computing
Fundamentals of fuzzy set theory, fuzzy measures and fuzzy integrals
Fuzzy systems with big data and cloud computing
Fuzzy optimization, decision analysis, decision making, multi- criteria decision making
Fuzzy image, speech and signal processing, vision and multimedia data
Soft computing in security systems
Industrial, financial, and medical applications
Fuzzy sets and soft computing in social sciences
Fuzzy software applications
Adaptive, hierarchical, and evolvable fuzzy systems
Neuro-fuzzy, genetic-fuzzy and other hybrid systems

In addition to regular oral and poster presentations, the conference will include a full program of tutorials, workshops, panels, special sessions and keynote presentations. Full details of the submission process will be made available on the conference website.

Important Dates:

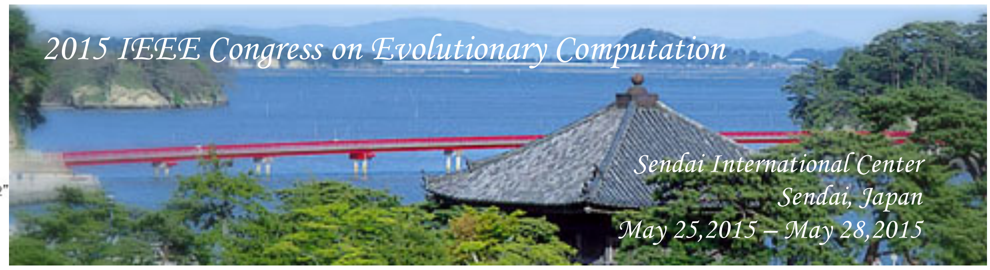
Special session, tutorial and panel session proposals: **November 15, 2014**
Notification of acceptance for tutorials and sessions: **December 15, 2014**
Paper submission: **January 23, 2014**
Notification of acceptance for papers: **March 16, 2015**
Camera-ready papers submission: **April 17, 2015**
Early registration: **May 1, 2015**
Conference: **August 2-5, 2015**



www.fuzzieee2015.org

IEEE

IEEE Computational Intelligence Society



IEEE Congress on Evolutionary Computation

The annual IEEE Congress on Evolutionary Computation (IEEE CEC) will be held during May 25-28, 2015, at Sendai International Center, Sendai, Japan.

Sponsors

IEEE Computational Intelligence Society (CIS)
Previously sponsored by the former Evolutionary Programming Society and the Institution of Engineering and Technology

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Call for Contributed Papers

The annual IEEE CEC is one of the leading events in the field of evolutionary computation. It covers all topics in evolutionary computation including:

- **Ant colony optimization**
- **Artificial life**
- **Agent-based systems**
- **Bioinformatics and bioengineering**
- **Coevolution and collective behavior**
- **Combinatorial and numerical optimization**
- **Constraint and uncertainty handling**
- **Evolutionary data mining**
- **Evolutionary learning systems**
- **Evolvable/adaptive hardware and systems**
- **Evolving neural networks and fuzzy systems**
- **Evolutionary multi-objective optimization**
- **Molecular and quantum computing**
- **Particle Swarm Optimization**
- **Artificial immune systems**
- **Representation and operators**
- **Industrial applications of EC**
- **Evolutionary game theory**
- **Cognitive systems and applications**
- **Computational finance and economics**
- **Estimation of distribution algorithms**
- **Evolutionary design**
- **Evolutionary scheduling**

IEEE CEC 2015 will feature a world-class conference that aims to bring together researchers and practitioners in the field of evolutionary computation and computational intelligence from all around the globe. Technical exchanges within the research community will encompass keynote lectures, regular and special sessions, tutorials, and competitions as well as poster presentations. In addition, participants will be treated to a series of social functions, receptions, and networking to establish new connections and foster everlasting friendship among fellow counterparts.

Prospective authors are invited to contribute high-quality papers to IEEE CEC 2015. All papers are to be submitted electronically through the IEEE CEC 2015 website http://www.cec2015.org.

For IEEE CEC inquiries please contact Conference Chair: Shigeru Obayashi at obayashi@ieee.org
For Program inquiries please contact Program Chair: Tadahiko Murata at murata@res.kutc.kansai-u.ac.jp.

Call for Special Sessions

The IEEE CEC 2015 Program Committee solicits proposals for special sessions within the technical scopes of the Congress. Special sessions, to be organized by international recognized experts, aim to bring together researchers in special focused topics. Papers submitted for special sessions are to be peer-reviewed with the same criteria used for the contributed papers. Proposals should include the session title, a brief description of the scope and motivation, biographic and contact information of the organizers. Researchers interested in organizing special sessions are invited to submit formal proposal to the Special Session Chair:

Hisao Ishibuchi at hisaoi@cs.osakafu-u.ac.jp.

Call for Tutorials

IEEE CEC 2015 will also feature pre-Congress tutorials, covering fundamental and advanced evolutionary computation topics. A tutorial proposal should include title, names and affiliations of presenters, abstract, outline, intended audience and expected enrollment, and presenter biography. We invite you to submit proposals to the Tutorial Chair:

Clare Bates Congdon at congdon@usm.maine.edu.

Call for Competitions

IEEE CEC 2015 will host competitions to stimulate research in evolutionary computation, promote fair evaluations, and attract many participants. The proposals for competitions should include descriptions of the problems addressed, motivations and expected impact on evolutionary computation, data description, evaluation procedures and established baselines, schedules, anticipated number of participants, and a biography of the main team members. We invite you to submit proposals to the Competitions Chair:

Simon M. Lucas at sml@essex.ac.uk.

General inquiries for IEEE CEC 2015 should be sent to the General Chair:
Shigeru Obayashi at obayashi@ieee.org

Important Dates

Competition proposals submission deadline
September 26, 2014

Special session proposals submission deadline
October 31, 2014

Special session decision notification
November 14, 2014

Paper submission deadline
December 19, 2014

Tutorial proposals submission deadline
January 9, 2015

Tutorial decision notification
January 23, 2015

Paper acceptance notification
February 20, 2015

Final paper submission deadline
March 13, 2015

Early registration
March 13, 2015

Conference dates
May 25-28, 2015

IEEE World Congress on Computational Intelligence

25-29 July 2016, Vancouver, Canada

IEEE WCCI 2016
Vancouver Canada

The IEEE World Congress on Computational Intelligence (IEEE WCCI) is the largest technical event in the field of computational intelligence. The IEEE WCCI 2016 will host three conferences: The 2016 International Joint Conference on Neural Networks (IJCNN 2016), the 2016 IEEE International Conference on Fuzzy Systems (FUZZ-IEEE 2016), and the 2016 IEEE Congress on Evolutionary Computation (IEEE CEC 2016) under one roof. It encourages cross-fertilization of ideas among the three big areas and provides a forum for intellectuals from all over the world to discuss and present their research findings on computational intelligence.

IEEE WCCI 2016 will be held at the Vancouver Convention Center, Vancouver, Canada. Vancouver is Canada's Pacific gem, offering a winning combination of world-class hotels, meeting venues, and restaurants in a setting of spectacular beauty. Few convention cities can offer such a wide range of cosmopolitan amenities in a downtown core that is safe, clean, pedestrian friendly, and stunning in its backdrop of mountains and ocean.

IJCNN is the flagship conference of the International Neural Network Society and the IEEE Computational Intelligence Society. It covers a wide range of topics in the field of neural networks, from biological neural network modeling to artificial neural computation.

FUZZ-IEEE is the foremost conference in the field of fuzzy systems. It covers all topics in fuzzy systems, from theory to applications.

IEEE CEC is a major event in the field of evolutionary computation, and covers all topics in evolutionary computation from theory to applications.

Call for Papers

Papers for IEEE WCCI 2016 should be submitted electronically through the Congress website at www.wcci2016.org, and will be refereed by experts in the fields and ranked based on the criteria of originality, significance, quality and clarity.

Call for Tutorials

IEEE WCCI 2016 will feature pre-Congress tutorials, covering fundamental and advanced topics in computational intelligence. A tutorial proposal should include title, outline, expected enrollment, and presenter/organizer biography. Inquiries regarding tutorials should be addressed to Tutorials Chairs.

Call for Special Session Proposals

IEEE WCCI 2016 solicits proposals for special sessions within the technical scope of the three conferences. Special sessions, to be organized by internationally recognized experts, aim to bring together researchers in special focused topics. Cross-fertilization of the three technical disciplines and newly emerging research areas are strongly encouraged. Inquiries regarding special sessions and proposals should be addressed to Special Sessions Chairs.

Call for Competition Proposals

IEEE WCCI 2016 will host competitions to stimulate research in computational intelligence. A competition proposal should include descriptions of the problem(s) addressed, evaluation procedures, and a biography of the organizers. Inquiries regarding competitions should be addressed to the Competitions Chair.

Important Dates

- 15 Nov 2015 — Special Session & Workshop Proposals Deadline
- 15 Dec 2015 — Competition & Tutorial Proposals Deadline
- 15 Jan 2016 — Paper Submission Deadline
- 15 Mar 2016 — Paper Acceptance Notification Date
- 15 Apr 2016 — Final Paper Submission & Early Registration Deadline
- 25-29 Jul 2016 — IEEE WCCI 2016 Vancouver, Canada

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AUTHOR INDEX

Page numbers of papers where a person is the first author are shown in bold. The italic page numbers point to sessions of which the person is a chair.

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