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Parallel Problem Solving from Nature – PPSN XV

15th International Conference
Coimbra, Portugal, September 8–12, 2018
Proceedings, Part I

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Preface

During September 8–12, 2018, researchers from all over the world gathered in Coimbra, Portugal, for the 15th International Conference on Parallel Problem Solving from Nature (PPSN XV). Far more than a European event, this biennial meeting has established itself among the most important and highly respected international conferences in nature-inspired computation worldwide since its first edition in Dortmund in 1990. These two LNCS volumes contain the proceedings of the conference.

We received 205 submissions from 44 countries. An extensive review process involved over 200 reviewers, who evaluated and reported on the manuscripts. All papers were assigned to at least three Program Committee members for review. A total of 745 review reports were received, or over 3.6 reviews on average per manuscript. All review reports were analyzed in detail by the Program Chairs. Where there was disagreement among reviewers, the Program Chairs also evaluated the papers themselves. In some cases, discussion among reviewers with conflicting reviews was promoted with the aim of making as accurate and fair a decision as possible. Overall, 79 manuscripts were selected for presentation and inclusion in the proceedings, which represents an acceptance rate just below 38.6%. This makes PPSN 2018 the most selective PPSN conference of the past 12 years, and reinforces its position as a major, high-quality evolutionary computation scientific event.

The meeting began with an extensive program of 23 tutorials and six workshops covering a wide range of topics in evolutionary computation and related areas, including machine learning, statistics, and mathematical programming. Tutorials offered participants the opportunity to learn more about well-established, as well as more recent, research, while workshops provided a friendly environment where new ideas could be presented and discussed by participants with similar interests.

In addition, three distinguished invited speakers delivered keynote addresses at the conference. Ahmed Elgammal (Rutgers University, USA), Francis Heylighen (Vrije Universiteit Brussel, Belgium), and Kurt Mehlhorn (Max Planck Institute for Informatics, Saarbrücken, Germany) spoke on advances in the area of artificial intelligence and art, foundational concepts and mechanisms that underlie parallel problem solving in nature, and models of computation by living organisms, respectively.

We thank the authors of all submitted manuscripts, and express our appreciation to all the members of the Program Committee and external reviewers who provided thorough evaluations of those submissions. We thank the keynote speakers, tutorial speakers, and workshop organizers for significantly enriching the scientific program with their participation. To all members of the Organizing Committee and local organizers, we extend our deep gratitude for their dedication in preparing and running the conference. Special thanks are due to the University of Coimbra for hosting the conference and, in particular, to INESC Coimbra, CISUC, the Department of Informatics Engineering, the Department of Mathematics, and the International Relations Unit, for their invaluable contribution to the organization of this event, and to the

sponsoring institutions for their generosity. Finally, we wish to personally thank Carlos Henggeler Antunes for his unconditional support.

September 2018

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Organization

PPSN 2018 was organized by INESC Coimbra and CISUC, and was hosted by the University of Coimbra, Portugal. Established in 1290, the University of Coimbra is the oldest university in the country and among the oldest in the world. It is a UNESCO World Heritage site since 2013.

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Invited Talks

The Shape of Art History in the Eyes of the Machine

Ahmed Elgammal

Art and Artificial Intelligence Laboratory, Rutgers University

Advances in Artificial Intelligence are changing things around us. Is art and creativity immune from the perceived AI takeover? In this talk I will highlight some of the advances in the area of Artificial Intelligence and Art. I will argue about how investigating perceptual and cognitive tasks related to human creativity in visual art is essential for advancing the fields of AI and multimedia systems. On the other hand, how AI can change the way we look at art and art history.

The talk will present results of recent research activities at the Art and Artificial Intelligence Laboratory at Rutgers University. We investigate perceptual and cognitive tasks related to human creativity in visual art. In particular, we study problems related to art styles, influence, and the quantification of creativity. We develop computational models that aim at providing answers to questions about what characterizes the sequence and evolution of changes in style over time. The talk will also cover advances in automated prediction of style, how that relates to art history methodology, and what that tells us about how the machine sees art history. The talk will also delve into our recent research on quantifying creativity in art in regard to its novelty and influence, as well as computational models that simulate the art-producing system.

Self-organization, Emergence and Stigmergy: Coordination from the Bottom-up

Francis Heylighen

Evolution, Complexity and Cognition Group,
Center Leo Apostel, Vrije Universiteit Brussel

The purpose of this presentation is to review and clarify some of the foundational concepts and mechanisms that underlie parallel problem solving in nature. A problem can be conceived as a tension between the present, "unfit" state and some fit state in which the tension would be relaxed [2]. Formulated in terms of dynamic systems, the solution is then a fitness peak, a potential valley, or most generally an attractor in the state space of the system under consideration. Solving the problem means finding a path that leads from the present state to such an attractor state. This spontaneous descent of a system into an attractor is equivalent to the self-organization of the components or agents in the system, meaning that the agents mutually adapt so as to achieve a stable interaction pattern. The interaction between agents can be conceived as a propagation of challenges: a challenge is a state of tension that incites an agent to act so as to reduce the tension. That action, however, typically creates a new challenge for one or more neighboring agents, who act in turn, thus creating yet further challenges. The different actions take place in parallel, producing a "wave" of activity that propagates across the environment. Because of the general relaxation dynamics, this activity eventually settles in an attractor. The stability of the resulting global configuration means that the different agents have now "coordinated" their actions into a synergetic pattern: a global "order" has emerged out of local interactions [1]. Such self-organization and "natural problem solving" are therefore in essence equivalent. Two mechanisms facilitate this process: (1) order from noise [4] notes that injecting random variation accelerates the exploration of the state space, and thus the discovery of deep attractors; (2) stigmergy means that agents leave traces of their action in a shared medium. These traces challenge other agents to build further on the activity. They function like a collective memory and communication medium that facilitates coordination without requiring either top-down control or direct agent-to-agent communication [3].

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On Physarum Computations

Kurt Mehlhorn

Max Planck Institute for Informatics, Saarland Informatics Campus, Saarbrücken

Let c be a positive vector in $\mathbb{R}^m$, let $A \in \mathbb{R}^{n \times m}$ and $b \in \mathbb{R}^n$. Consider

$$\text{minimize } c^T|f| \text{ subject to } Af = b. \tag{1}$$

The solution is a feasible f of minimum weighted 1-norm. The Physarum dynamics operates on a state $x \in \mathbb{R}^m_{>0}$. The state evolves according to the system of differential equations

$$\dot{x} = q - x,$$

where q is the minimum energy feasible solution, i.e.,

$$q = \text{argmin}_f \left\{ \sum_e r_e f_e^2 \mid Af = b \right\} \quad \text{and} \quad r_e = c_e / x_e. \tag{2}$$

In [1] it is shown that the dynamics (2) converges to an optimal solution of (1). Previously, this was known for the special case of the undirected shortest path problem [2–4]; here A is the node-arc incidence matrix of a directed graph and b is the demand vector. Further work can be found in [8–11].

The theoretical investigation of the Physarum dynamics was motivated by wet-lab experiments [5]. The theoretical model was introduced by [6], and convergence for the case of parallel links was shown in [7].

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