A Potential of Evolutionary Rule-based Machine Learning for Real World Applications

Keiki Takadama
The University of Electro-Communications
1-5-1 Chofugaoka Chofu, Tokyo, Japan
keiki@inf.uec.ac.jp

Extended Abstract

This paper explores a potential of *Evolutionary Rule-based Machine Learning* (ERML) by showing how ERML succeeds in real world applications. Generally, ERML is defined as a method that integrates *(rule-based) machine learning* with *evolutionary computation*, where the former method contributes to a *local* search while the latter method contributes to a *global* search. From such an integrated feature of ERML, one of the fundamental interests in ERML is how to control interactions between learning and evolution to produce a performance that cannot be achieved by either of these methods alone.

  Since real world problems are generally hard to be solved due to many and strict conditions, the design of interactions between learning and evolution is very critical issue of ERML. Towards this issue, the following different types of real world applications are tackled by the proposed ERML.

(1) Program evolution in on-board computer (OBC) of space satellite;

(2) Knowledge mining for deep and stable sleep for care support of aged persons;

(3) Printed circuit board (PCB) design in computer-aided design (CAD); and

(4) Bus transport network generation in disaster situations.

  The intensive simulations in the above four real world applications have revealed the following implications.

(1) The proposed ERML, which is based on *Tierra* studied in the context of artificial life, can evolve the sophisticated computer programs (*i.e.*, the small size program) from the simple programs (*i.e.*, the large size program) through the bit inversion of DRAM in OBC by exposing space radiation, where the bit inversion is a trigger to evolve the programs as the *mutation* like evolutionary computation [1];

(2) The proposed ERML, which is based on *learning classifier system (LCS)*, successfully mines the knowledge that contributes to deriving deep and stable sleep of aged persons, *i.e.*, the daily activities that provides nine years younger sleep in the healthy aged persons and seven years younger sleep even in dementia persons who are hard to have a deep sleep in comparison with non-dementia persons [4];

(3) The proposed ERML, which introduces four kind of mechanisms of *organizational learning* studied in the context of management science into LCS, successfully designs a good PCB of a plasma display produced by Panasonic corporation, which cannot be achieved by human experts [3]; and

(4) The proposed ERML, which is based on the multiagent approach (*i.e.*, a route corresponds to an agent), can generate the bus route network in disaster situations, which effectively transports many stranded persons including ones who wait around the station as the passenger traffic bottlenecks [2].

  These implications suggest that the proposed ERMLs can provide good results in both the *single agent* environment (in (1) and (2)) and the *multiagent* environment (in (3) and (4)) and can cope with both the problem using constant and accurate data (in (1) and (3)) and the problem using noisy and inaccurate data (in (2) and (4)).

CCS Concepts

•**Computing methodologies → Machine learning; Artificial intelligence;** •**Applied computing** → Physical sciences and engineering; Life and medical sciences;

Keywords

Evolutionary Rule-based Machine Learning, Learning Classifier System, Application

1. REFERENCES

[1] Harada, T., Otani, M., Ichikawa, Y., Hattori, K., Sato, H., and Takadama, K.: "Robustness to Bit Inversion in Registers and Acceleration of Program Evolution in On-Board Computer," *Journal of Advanced Computational Intelligence and Intelligent Informatics (JACIII)*, Vol.15, No. 8, pp. 1175–1185, 2011.

[2] Kitagawa, H., Sato, K., and Takadama, K.: "Multiagent-based Sustainable Bus Route Optimization in Disaster", Journal of Information Processing, Vol. 22, No. 2, pp. 235–242, 2014.

[3] Takadama, K., Terano, T., Shimohara, K., Hori, K., and Nakasuka, S.: "Making Organizational Learning Operational: Implication from Learning Classifier System", *Computational and Mathematical Organization Theory (CMOT)*, Kluwer Academic Publishers, Vol. 5, No. 3, pp. 229–252, 1999.

[4] Takadama, K. and Nakata, M.: "Extracting Both Generalized and Specialized Knowledge by XCS using Attribute Tracking and Feedback," *2015 IEEE Congress on Evolutionary Computation (CEC2015)*, 2015, to appear.