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Editorial

Nature-inspired collective intelligence in theory and practice

When the first nature-inspired computational methods have appeared a few decades ago, they were welcomed by the scientific community with a mix of curiosity and scepticism. Over the years, however, these methods have shown their value not only for computer science, but also for several areas of engineering, as we witness more and more successful applications. As a consequence, a wide spectrum of applications and services has currently been developed and designed relying on various natural biological paradigms. The most known examples are swarm intelligence, evolutionary algorithms, and the artificial neural networks. These paradigms find their applications in the areas of network security, pervasive computing, mobile and embedded systems, pattern recognition, data classification and many others. Collective intelligence is a high-level phenomenon that emerges naturally from the interplay of collaboration and competition of many individuals of a population. It is usually defined as the ability of a group to solve problems than its individual members cannot solve on their own. Those natural phenomena are mimicked by the population-based, bio-inspired methods. It is of extreme importance to bridge collective methods with biological sciences and to try to draw an analogy between these disciplines. The collaborative work of individuals in a swarm can solve complex optimization problems in many areas of engineering. The artificial immune system can efficiently detect changes in the environment or deviations from the normal system behaviour via self-optimization and learning process. The concepts of intercellular information exchange can be used to learn: efficient dispatching, shortening of signalling pathways and modelling the control loop for a regulatory process in an organism. Some bio-ideas can be successfully exploited to elaborate sound strategies against cascading failures in the systems, or to provide insights into complex social phenomena such as terrorist cells.

The principle goal of this special issue is to highlight an ongoing research on different methodological and technological approaches of nature-inspired theory and collective intelligence as well as their applications to various areas. The selected examples cover the following topics: (i) nature-inspired methods for data mining; (ii) solving NP-hard problems by applying bio-inspired optimization; (iii) using the evolutionary approach with collaborations to discover semantic networks; (iv) intelligent image processing; (v) surface reconstruction problem; (vi) agent-based self-optimization of mobile networks; (vii) sequence alignment methods in bioinformatics (viii–xi) theory of swarm intelligence; (xii) cooperative clustering and (xiii) financial portfolios optimization. This special issue aims at gathering the cutting-edge research papers at the junction of nature-inspired collective intelligence methods and applications. A total of 106 papers from 26 different countries were submitted to the special issue. Due to space restrictions, not all high-quality papers could be published. After an extensive review process only 13 with top quality were selected (meaning that an acceptance rate was about 12%).

The papers are organized as follows. The first two papers deal with ant colony system. The first one, by Tzung-Pei Hong et al. uses a multi-level ant colony system-based mining algorithm that deals with both linguistic and quantitative data for constructing appropriate collection of membership functions in fuzzy data mining. The second one, authored by Zhigang Ren and Zuren Feng introduces a hybrid algorithm used to approximately solve the multiple-choice multidimensional knapsack problem by fusing Ant Colony Optimization and Lagrangian Relaxation. The paper by Jason J. Jung shows how collaboration between a query sampling method and an evolutionary algorithm can automatically extract metadata about information sources and optimize the integration of metadata in the form of a semantic network. The fourth and the fifth papers deal with image processing and surface reconstruction, respectively. Erik Cuevas et al. present the electromagnetism-like optimization, based on the principle of electromagnetic attraction and repulsion among charged particles. This innovative method is applied to the automatic detection of circular shapes embedded into digital images. In their paper, Akemi Galvez et al. apply a specially tailored genetic algorithm for iteratively fitting a given cloud of data points in surface reconstruction, a common problem that originates from reverse engineering applications. The paper by Iva Bojic et al. uses fireflies-synchronized agents, a swarm intelligence approach, for auto-tuning a mobile network to reduce the telecommunication operatoŕs costs without reducing the quality of provided services for users. In the seventh paper, Jun Sun et al. use a quantum-behaved particle swarm optimization (PSO) algorithm for training a hidden Markov model that is applied to a well-known NP-hard problem in bioinformatics, the multiple sequence alignment. The successive four papers deal with particle swarm optimization approaches. Nitin Sharma et al. use discrete particle swarm optimization approach for allocating sub-channels in

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wireless systems that employs the orthogonal frequency division multiple access technique. The ninth paper by Han Huang et al. proposes an example-based learning particle swarm optimization algorithm that uses multiple global best positions as elite examples to retain the diversity of the particle swarm. Lili Liu et al. focus on a new force-imitated dynamics for the movement of particles with the combination of the near-neighbour effect in nature and the mechanics theory in physics for locating multiple global optima. In the 11th paper, Sayan Ghosh et al., provide a probabilistic analysis of the particle interaction and information exchange in a local best PSO with a variable random neighbourhood topology. The penultimate paper by Abbas Ahmadi et al. brings up a new bio-inspired multiple cooperative swarms algorithm to deal with clustering problem and to estimate the model order selection using stability analysis. Finally, Claus Aranha et al. address the selection and weighting of financial assets in order to form an investment strategy that maximizes a return value and at the same time minimizes a risk indicator. In particular, the authors investigate how to construct an extension to the memetic algorithm, which leads to a significantly improved performance when compared to previous evolutionary methods.

We would like to thank the Editor-in-Chief, Witold Pedrycz, for giving us the opportunity to organize this special issue and for his close cooperation. We also thank our journal manager Jie Chen for great help in the organization of this issue. Special thanks go to the reviewers for their diligent work and thorough comments. Last, but not least, we would like to thank all the authors who submitted their best work and carefully revised it to meet the high standards of this journal. Finally, we hope the readers will find the papers both useful and inspiring.

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