Special Section on Swarm-Based Algorithms and Applications in Computational Biology and Bioinformatics

Ying Tan and Yuhui Shi

INSPIRED by the collective behaviors of biological or natural swarms, swarm intelligence has been established and become an important paradigm in the community of computational intelligence in recent years. The swarm intelligence is to study the collective behavior of decentralized and self-organized systems which may consist of a population of simple agents which can communicate (either directly or indirectly) locally with each other by acting on their local environment. Although the agent in a swarm only follows some simple rules, the interactions among those agents are able to lead to the emergence of a very complicated global behavior, far beyond the capability of individual agents, which can be used to deal with very complicated problems occurred in real-world applications.

In order to foster the research of swarm intelligence, the prestigious conference named International Conference on Swarm Intelligence (ICSI) series (official website: http://www.ic-si.org) is exclusively devoted to be a forum for academia and practitioners to exchange their latest advantages in theories, technologies, and applications in the field of swarm intelligence and related areas. This annual series conference has become one of the most important and widely-recognized international events in the community of swarm intelligence. ICSI'2016 is the seventh ICSI event successfully held in Padma Resort at Legian, Bali, Indonesia, from June 25 to 30, 2016, which attracted more than 200 researchers to participate and share their latest results and innovative ideas.

This special section contains seven high-quality articles selected strictly from more than 300 submissions of the ICSI'2016 by the Conference International Program Committee and are substantially extended by authors. All of the seven articles undertook and passed through the same peer-reviewing process as normal regular papers in this transactions.

These articles are primarily dealing with either novel bio-inspired swarm intelligence algorithms and their improvements as well as some practical applications in multi-objective optimization, network community detection, curve fitting, and swarm robotics, etc. What follows is the concise description of each article.

In the first article, "Coevolutionary Structure-Redesigned-Based Bacterial Foraging Optimization," Ben Niu, Jing Liu, Teresa Wu, Xianghua Chu, Zhengxu Wang, and Yanmin Liu proposed a Co-evolutionary Structure-Redesigned-Based Bacteria Foraging Optimization (CSRBFO) based on the natural phenomenon that most living creatures tend to cooperate with each other to fulfill tasks efficiently, which contains the two steps of "chemotaxis" and "elimination & dispersal." In order to speedup convergence, a co-evolutionary strategy by which all bacteria can learn from each other and search for optima cooperatively is incorporated into the chemotactic step. In the elimination & dispersal step, the three-stage evolutionary strategy with different learning methods for keeping diversity is deeply studied while an evaluation of the convergence status is also added to determine whether bacteria should move on to the next stage. In such away, the combination of co-evolutionary strategy and convergence status evaluation is expected to balance exploration and exploitation well.

In the second article, "Environment Sensitivity-Based Cooperative Co-Evolutionary Algorithms for Dynamic Multi-Objective Optimization," Biao Xu, Yong Zhang, Dunwei Gong, Yinan Guo, and Miao Rong described a cooperative co-evolutionary strategy based on environment sensitivities for solving dynamic multi-objective optimization algorithms (DMOPs). The proposed strategy is to group decision variables into two subcomponents according to their interrelation with environment. Adopting two populations to cooperatively optimize the two subcomponents, two prediction methods, i.e., differential prediction and Cauchy mutation, are respectively employed to accelerate their responses on the change of the environment. Furthermore, two improved DMOPs, i.e., DNSGAII-CO and DMOPSO-CO, are proposed by incorporating the above strategy into NSGA-II and multi-objective particle swarm optimization, respectively.

In the third article, "Robust Dynamic Multi-Objective Vehicle Routing Optimization Method," Yi-nan Guo, Jian Cheng, Sha Luo, and Dunwei Gong proposed a robust dynamic multi-objective vehicle routing method based on local optimization strategies to remedy the drawbacks like time-consuming in the dynamic multi-objective vehicle routing problems. The newly proposed method has three advantages: (a) After constructing optimal robust virtual routes considering all clients by adopting particle swarm optimization algorithm, static

- *Y. Tan is with the Key Laboratory of Machine Perception (MOE), Department of Machine Intelligence, School of EECS, Peking University, Haidian District, Beijing 100871, China. E-mail: ytan@pku.edu.cn.*
- *Y. Shi is with the Department of Computer Science and Engineering, Southern University of Science and Technology, Shenzhen 518055, China. E-mail: shiyh@sustc.edu.cn.*

For information on obtaining reprints of this article, please send e-mail to: reprints@ieee.org, and reference the Digital Object Identifier below.
Digital Object Identifier no. 10.1109/TCBB.2018.2879422

vehicle routes for fixed clients are formed by removing all dynamic clients from robust virtual routes. (b) The dynamically appeared clients append to be served according to their service demands and the vehicles' locations. Global vehicle routing optimization is triggered only when no suitable locations can be found for dynamic clients. (c) A metric measuring the algorithms' robustness is given. The statistical results show that the routes obtained by the proposed method have better stability and robustness but may be sub-optimum. Moreover, time-consuming global vehicle routing optimization is avoided as dynamic clients appear.

In the fourth article, "A Grouping Particle Swarm Optimizer with Personal-Best-Position Guidance for Large Scale Optimization," Weian Guo, Chengyong Si, Yu Xue, Yanfen Mao, Lei Wang, and Qidi Wu proposed a PSO variant, i.e., so-called Grouping PSO with Pbest Guidance (GPSO-PG) which maintains the population diversity by preserving the diversity of exemplars. On one hand, uniform random allocation strategy is adopted to assign particles into different groups and in each group the losers will learn from the winner. On the other hand, the personal historical best position of each particle in social learning rather than the current global best particle is employed. In such a way, the exemplars' diversity increases and the effect from the global best particle is eliminated.

In the fifth article, "Network Community Detection Based on the *Physarum*-Inspired Computational Framework," Chao Gao, Mingxin Liang, Xianghua Li, Zili Zhang, Zhen Wang, and Zhili Zhou proposed a general Physarum-based computational framework for community detection by inspired from the computational capability and positive feedback mechanism in the wake of foraging process of Physarum. Based on the proposed framework, the inter-community edges can be identified from the intra-community edges in a network and the positive feedback of solving process in an algorithm can be further enhanced, which are used to improve the efficiency of original optimization-based and heuristic-based community detection algorithms, respectively.

In the sixth article, "Immunological Approach for Full NURBS Reconstruction of Outline Curves from Noisy Data Points in Medical Imaging," Andrés Iglesias, Akemi Gálvez, and Andreina Avila described the first method in the literature to solve the full non-uniform rational B-splines (NURBS) curve reconstruction problem in all its generality, and then proposed a novel construction method which is based on a combination of two techniques: an immunological approach to perform data parameterization, breakpoint placement, and weight calculation, and least squares minimization to compute the control points. This procedure is iteratively repeated until no further improvement is achieved. Finally, the proposed method has been applied to reconstruct some outline curves from MRI brain images with satisfactory results.

In the seventh article, "Swarm Robots Search for Multiple Targets Based on an Improved Grouping Strategy," Qirong Tang, Lu Ding, Fangchao Yu, Yuan Zhang, Yinghao Li, and Haibo Tu proposed an improved grouping strategy based on constriction factors in Particle Swarm Optimization for multiple targets in collaboration in unknown environments for swarm robots. Under this strategy, robots are grouped after several iterations of stochastic movements, which considers the detection range of robots and environmental information they have sensed. The group structure may change dynamically and each group focuses on searching one target. Obstacle avoidance is considered during the search process. Simulation compared with previous method demonstrates the adaptability and accuracy of the proposed strategy in multiple targets searching.

This special section could be regarded as a snapshot of the state of art swarm-based algorithms and applications in computational biology for attracting more researchers who may has interests in the research related to swarm intelligence and its applications in biological science and engineering for more achievements.

The guest editors wish this special section of the transactions will stimulate more new directions and solutions that can lead to both theoretical insights and practical applications in swarm intelligence research. They appreciate the former associate editor-in-chief, Prof. Dong Xu, and the former editor-in-chief, Prof. Ying Xu, and editor-in-chief, Prof. Aidong Zhang, for giving them this opportunity to organize this special section. Then, they also are grateful to all of the reviewers for their invaluable reviews. At last, they would like to thank all of the authors who made efforts in writing and revising their papers carefully and earnestly by incorporating valuable comments from reviewers and editors. This work was supported by the Natural Science Foundation of China (61673025) and partially by the National Key Basic Research Development Plan (973 Plan) Project of China (2015CB352302).

Ying Tan,
Peking University
Yuhui Shi,
Southern University of Science and Technology
Guest Editors

Ying Tan is a full professor with Peking University. He is the inventor of the Fireworks Algorithm (FWA). He serves as the editor-in-chief of the *International Journal of Computational Intelligence and Pattern Recognition* (*IJCIPR*), the associate editor of the *IEEE Transactions on Evolutionary Computation* (*TEC*), *IEEE Transactions on Cybernetics* (*CYB*), etc. He has been the founding general chair of the ICSI International Conference series ICSI 2010-2018. His research interests include computational intelligence, swarm intelligence, swarm robotics, data mining, machine learning, etc. He is a senior member of the IEEE.

Yuhui Shi is chair professor of the Department of Computer Science and Engineering, Southern University of Science and Technology (SUSTech). His main research interests include computational intelligence techniques (including swarm intelligence) and their applications. He is the editor-in-chief of the *International Journal of Swarm Intelligence Research* and associate editor of the *IEEE Transactions on Evolutionary Computation* and so on. He has been the founding program chair of ICSI Series Conference (ICSI 2010-2018), etc. He is a fellow of the IEEE.