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Editorial

Swarm Intelligence in Engineering

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Swarm intelligence (SI) is an artificial intelligence technique based on the study of behavior of simple individuals (e.g., ant colonies, bird flocking, animal herding, and honey bees), which has attracted much attention of researchers and has also been applied successfully to solve optimization problems in engineering. However, for large and complex problems, SI algorithms consume often much computation time due to stochastic feature of the search approaches. Therefore, there is a potential requirement to develop efficient algorithm to find solutions under the limited resources, time, and money in real-world applications.

Within this context, this special issue servers as a forum to highlight the most significant recent developments on the topics of SI and to apply SI algorithms in real-life scenario. The works in this issue contain new insights and findings in this field. A broad range of topics has been discussed, especially in the following areas, benchmarking and evaluation of new SI algorithms, convergence proof for SI algorithms, comparative theoretical and empirical studies on SI algorithms, and SI algorithms for real-world application.

Some works focus on the application of genetic algorithm in different area, for example, G. Ning et al.'s "*Economic analysis on value chain of taxi fleet with battery-swapping mode using multiobjective genetic algorithm*" presents an economic analysis model on value chain of taxi fleet with battery-swapping mode in a pilot city. A multiobjective genetic algorithm is used to solve the problem. The real data collected from the pilot city proves that the multiobjective genetic algorithm is tested as an effective method to solve this problem.

B. Zhenming et al. "*Direct index method of beam damage location detection based on difference theory of strain modal shapes and the genetic algorithms application*" applies direct index method SMSD and the Genetic Algorithms into structural damage identification. Numerical simulation shows that the criteria of damage location detection can be obtained by strain mode difference curve through cubic spline interpolation.

F. Zong et al.'s "*Daily commute time prediction based on genetic algorithm*" presents a joint discrete-continuous model for activity-travel time allocation by employing the ordered probit model for departure time choice and the hazard model for travel time prediction. Genetic algorithm (GA) is employed for optimizing the parameter in the hazard model. The results also show that the genetic algorithm contributes to the optimization and thus the high accuracy of the hazard model.

Qu et al.'s "*The optimized transport scheme of empty and heavy containers with novel genetic algorithm*" proposed a model with objective maximizing the route benefits to design the transport scheme of empty and heavy containers reasonably. A novel GA is developed to solve the model. The case study about China-Europe route proves that this model can improve the liner company's benefits effectively.

W. Juan et al.'s "*Genetic algorithm for multiuser discrete network design problem under demand uncertainty*" presents a bilevel model for discrete network design. An iterative approach including an improved genetic algorithm and a Frank-Wolfe algorithm is used to solve the bilevel model. The numerical results on the Nguyen Dupuis network show

that the model and the related algorithms were effective for discrete network design.

Z. Yu et al.'s "*Dynamic route guidance using improved genetic algorithms*" presents an improved genetic algorithm (IGA) for dynamic route guidance algorithm. The proposed IGA designs a vicinity crossover technique and a greedy backward mutation technique to increase the population diversity and strengthen local search ability. The simulation results show the effectiveness of the proposed algorithm.

Y. Li and Z. Sun's "*Articulated human motion tracking using sequential immune genetic algorithm*" proposed a novel generative method for human motion tracking in the framework of evolutionary computation. The paper designed an IGA-based method to estimate human pose from static images. It also proposed a sequential IGA (S-IGA) algorithm by incorporating the temporal continuity information into the traditional IGA. Experimental results show that our IGA-based pose estimation method can achieve viewpoint invariant 3D pose reconstruction, and the S-IGA-based tracking method can achieve accurate and stable tracking of 3D human motion.

Some works present improved algorithm based on particle swarm optimization. J. Yao and D. Han "*Improved barebones particle swarm optimization with neighborhood search and Its application on ship design*" proposed a new BPSO variant called BPSO with neighborhood search (NSBPSO) to achieve a tradeoff between exploitation during the search process. In the paper, experiments are conducted on twelve benchmark functions and a real-world problem of ship design. Simulation results show that NSBPSO outperforms the standard PSO, BPSO, and six other improved PSO algorithms.

J. Xi et al.'s "*A hybrid algorithm of traffic accident data mining on cause analysis*" puts forward an improved association rule algorithm based on particle swarm optimization (PSO). The new method is used to analyze the correlation between traffic accident attributes and causes. T-test model and Delphi method were deployed to test and verify the accuracy of the improved algorithm, the result of which was ten times faster speed for random traffic accident data sampling analyses on average. And the final result proves that the improved algorithm was accurate and stable.

Y. Lin's "*Particle swarm optimization algorithm for unrelated parallel machine scheduling with release dates*" proposed a heuristic and a very effective particle swarm optimization (PSO) algorithm to tackle the problem of minimizing makespan for n jobs on m unrelated parallel machines with release dates. Computational results show that the proposed PSO is very accurate and that it outperforms the existing metaheuristic.

A. Szabo and L. de Castro's "*A constructive data classification version of the particle swarm optimization algorithm*" introduced new particle swarm optimization algorithm specially designed to solve continuous parameter optimization problems. The proposals were applied to wide range of databases from the literature, and the results show that they are competitive in relation to other approaches from the literature, with the advantage of having a dynamically constructed architecture.

Also, ant colony algorithm is discussed in some works. Q. Xu et al.'s "*Simulated annealing-based ant colony algorithm for tugboat scheduling optimization*" presents a hybrid simulated annealing-based ant colony algorithm to optimize the tugboat scheduling. In this paper, experiments are conducted to examine the effectiveness of the proposed algorithm for the tugboat scheduling problem.

G. Yan and D. Feng's "*Escape-route planning of underground coal mine based on improved ant algorithm*" proposed a new escape-route planning method of underground mines based on the improved ant algorithm. A tunnel network zoning method and max–min ant system method are used to improve the performance of the ant algorithm. Experiments show that the proposed method can find good escape routes correctly and efficiently and can be used in the escape-route planning of large and medium underground cone mines.

There are also some works discussing other algorithms in this field. J. Wu's "*Solving unconstrained global optimization problems via hybrid swarm intelligence approaches*" gives an overview of two efficient hybrid SGO approaches, namely, a real-coded genetic algorithm-based PSO (RGA-PSO) method and an artificial immune algorithm-based PSO (AIA-PSO) method. Numerical results indicate that the RGA-PSO and AIA-PSO approaches can be considered alternative SGO approaches for solving standard-dimensional UGO problems.

Z. Wei et al.'s "*Bus dispatching interval optimization based on adaptive bacteria foraging algorithm*" applied the improved bacterial algorithm to schedule the bus departing interval. Based on adaptive bacteria foraging algorithm (ABFA), a model on one bus line in Hohhot city in China was established and simulated. The final results showed that ABFA was most feasible in optimizing variables.

S. TUO et al.'s "*An improved harmony search based on teaching-learning strategy for unconstrained optimization problems*" presents an improved global harmony search algorithm named harmony search based on teaching-learning (HSTL) for high-dimensional complex optimization problems. The experimental results of 31 complex benchmark functions demonstrate that the HSTL method has strong convergence, robustness, and better balance capacity of space exploration and local exploitation on high-dimensional complex optimization problems.

Y. Xu et al.'s "*A simple and efficient artificial bee colony algorithm*" proposes a new artificial bee colony (NABC) algorithm, which modifies the search pattern of both employed and onlooker bees. Experiments are conducted on a set of twelve benchmark functions. Simulation results show that this approach is significantly better or at least comparable to the original ABC and seven other stochastic algorithms.

S. Zhong et al.'s "*Guidance compliance behavior on VMS based on SOAR cognitive architecture*" introduced SOAR to design the agent with the detailed description of the working memory, long-term memory, decision cycle, and learning mechanism based on the multiagent platform. Experiments are simulated many times under given simulation network and conditions. The results, including the comparison between guidance and no guidance, the state transition times, and average chunking times, are analyzed to

further study the laws of guidance compliance and learning mechanism.

Cuevas's "*A Swarm Optimization Algorithm for Multimodal Functions and its Application in Multi-circle Detection*" presents a new swarm multimodal optimization algorithm named as the Collective Animal Behavior (CAB). In the proposed algorithm, searcher agents emulate a group of animals which interact to each other based on simple biological laws that are modeled as evolutionary operators. Numerical experiments are conducted to compare the proposed method with the state-of-the-art methods on benchmark functions. The proposed algorithm has been also applied to the engineering problem of multi-circle detection, achieving satisfactory results.

G. Cabrera et al.'s "*A hybrid approach using an artificial bee algorithm with mixed integer programming applied to a large-scale capacitated facility location problem*" presents a hybridization of two different approaches applied to the well-known capacitated facility location problem (CFLP). The artificial bee algorithm (BA) is used to select a promising subset of locations (warehouses) which are solely included in the mixed integer programming (MIP) model. According to the results, combining the BA with a mathematical programming approach appears to be an interesting research area in the combinatorial optimization.

These articles demonstrate the advancement that swarm intelligence technologies have made for supporting problem solving in engineering. Developing the efficient algorithm to find solutions can provide solutions for large and complex problems under the limited resources, time, and money in real-world applications. We would like to express our gratitude to the many reviewers for their hard works. We would also like to thank the authors for their contributions to the special issue. This special issue could not have been completed without their dedication and support.

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