Guest Editorial

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Computational Intelligence in Production and Logistics Systems: Solving Vehicle Routing, Supply Chain Network, and Air-Traffic Trajectory Planning Problems

The advancement of computer technology in recent years has allowed researchers to develop efficient optimization techniques for solving large-scale problems in various fields and helped practitioners to incorporate some of these techniques into their planning activities through specific integrated decision support systems. Despite this, many real-world problems still cannot be solved within reasonable computation times using exact algorithms because of the complexities associated with the large number of decision variables involved and the extent of the constraints imposed. As a consequence, non-exact methods such as custom-designed heuristics, search algorithms and metaheuristic approaches have become increasingly popular due to their speed, ease of implementation, flexibility for adaption, and quality of solutions. Among them, computational intelligence approaches inspired by principles of nature such as evolutionary algorithms, swarm intelligence algorithms, artificial neural networks and fuzzy logic have emerged as a rapidly growing research area. These approaches have been applied to various problems in different fields [1–5].

Likewise, many complex problems arising in the management of production and logistics activities can be tackled using effective computational intelligence methods (e.g., see [6–9]). In line with the *Computational Intelligence in Production and Logistics Systems (CIPLS)* symposium, which is regularly held as part of the *IEEE Symposium Series on Computational Intelligence (SSCI)*[1], this special issue aims to address problems and challenges related to the design, planning, and control of production and logistics systems using state-of-the-art computational intelligence approaches. It has a broad theme covering decision-making problems at the strategic, tactical, and operational levels in different production and logistics systems, and encompassing a large collection of topics from aggregate planning to job scheduling and dispatching, from logistics network design to vehicle routing and scheduling.

We solicited original, high quality papers presenting substantial results on the development and implementation of novel computational intelligence approaches that exhibit superior performances as compared to other optimization methods. The special issue attracted considerable attention with 33 submissions, of which 11 tackled production planning problems and 21 were related to logistics and supply chain management (the remaining one attempted to solve a general combinatorial optimization problem). A rigorous two-round review process was carried out, where each submitted manuscript was evaluated by at least three independent reviewers. In fact, most of the submissions received feedback from four to five reviewers. In the end, only 3 papers have been accepted for inclusion in the current special issue, all of which are associated with logistics and transportation.

The first paper by Wei et al. tackles the heterogeneous fleet vehicle routing problem with three-dimensional (3D) loading constraints (3L-HFVRP). In this problem, vehicles with different weight and volume capacities service a set of customers demanding for 3D, rectangular shaped items. The sequence of the deliveries is restricted by the loading/unloading constraints of the vehicles. The objective is to minimize the total transportation cost, which consists of the fixed cost of the vehicles and variable travel cost. An adaptive variable neighborhood search (AVNS) approach has been proposed by Wei et al. to solve this challenging problem. They use Trie data structure to keep track of the information associated with the routes and the computational effort spent, and Fibonacci heap data

[1]The first CIPLS was held as a workshop during SSCI 2011 in Paris, France, followed by the second CIPLS symposium held during SSCI 2013 in Singapore. The third CIPLS symposium will take place during SSCI 2014 in Orlando, Florida, USA. After each CIPLS symposium, a CIPLS special issue will be organized. The first such special issue was published in the *International Journal of Production Economics* [9]. This special issue is the second one.

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structure to maintain possible moves and the assignments of the vehicle type. The performance of AVNS has been tested through a computational study using benchmark instances of the capacitated vehicle routing problem with 3D loading constraints (3L-CVRP) and pure heterogeneous fleet vehicle routing problem (HFVRP) as well as newly generated instances of the 3L-HFVRP. Their numerical results show that the proposed method is effective, achieving good solutions in the pure HFVRP and improving several best solutions in the 3L-CVRP.

In the second paper, Castillo-Villar and Herbert-Acero take into account quality-related costs in addition to the operational and logistics costs while designing a capacitated supply chain network. In their so-called Supply Chain Network Design with Cost of Quality (SCND-COQ) model, quality-related costs include the prevention, inspection, rework, failure, and opportunity costs. Castillo-Villar and Herbert-Acero develop two solution procedures for the SCND-COQ model, based on a Genetic Algorithm (GA) and a Simulated Annealing (SA) method respectively, coupled with a nonlinear solver. Their experimental study shows that the GA-based procedure provides better solutions than the SA-based procedure in all the instances tested. In addition, the results reveal that COQ corresponds to 11% of the overall profit, playing a significant role in the SCND decision-making process.

The ever increasing global air-traffic volume is making strategic trajectory planning vital for maintaining the required safety level in the aviation industry. In the third and final paper of the special issue, Chaimatanan et al. present a strategic trajectory planning methodology that minimizes the total number of interactions between trajectories during a full day of air traffic over Europe. In their work, the flights are assigned alternative routes and departure times to separate their trajectories where the route/departure-time allocation problem is formulated as a mixed-integer program. To solve this large-scale optimization problem, which involves up to 30,000 trajectories, Chaimatanan et al. resort to a hybrid SA and hill-climbing algorithm incorporated with a computationally efficient interaction detection method for large trajectory sets. The numerical results show the effectiveness of the proposed approach in obtaining interaction-free trajectory plans.

To sum up, we hope that this special issue will inspire researchers in developing innovative computational intelligence mechanisms for solving complex real-world production and logistics problems. We wish to thank all the authors who contributed to the special issue by submitting their invaluable work and all the anonymous reviewers for providing us constructive and insightful comments during the review process. We would also like to thank Professor Hisao Ishibuchi, the Editor-in-Chief of *IEEE Computational Intelligence Magazine*, for giving us the opportunity to guest-edit this special issue and for his continuous support throughout the entire process. Last but not least, we hope the readers will enjoy reading the featured papers as much as we have enjoyed putting them together!

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