ARTICLE IN PRESS

Available online at www.sciencedirect.com

ScienceDirect

Computers & Operations Research ▮▮▮ (▮▮▮▮) ▮▮▮–▮▮▮

computers & operations research

www.elsevier.com/locate/cor

Editorial

"Meta-heuristics, in their original definition, are solution methods that orchestrate an interaction between local improvement procedures and higher level strategies to create a process capable of escaping from local optima and performing a robust search of a solution space. Over time, these methods have also come to include any procedures that employ strategies for overcoming the trap of local optimality in complex solution spaces, especially those procedures that utilize one or more neighborhood structures as a means of defining admissible moves to transition from one solution to another, or to build or destroy solutions in constructive and destructive processes." This definition stems from the preface of the handbook of meta-heuristics edited by Glover and Kochenberger [1].

In the past years very often ideas from biology were adapted to control these higher level strategies. *Ant Colony Optimization, Genetic Algorithms, Particle Swarm Optimization* are the most popular and most successful representatives of the group of bio-inspired search techniques.

The aim of this special issue is to present state-of-the-art papers in the field of bio-inspired meta-heuristics. This includes theoretical contributions such as runtime analyses, the development of new algorithms such as viral systems, and the hybridization with other approaches.

The first two contributions deal with Ant Colony Optimization. The paper "First steps to the runtime complexity analysis of ant colony optimization" by Walter J. Gutjahr is a theoretical work on the runtime complexity of Ant Colony Optimization. As the class of test problems under consideration, a slight generalization of the well-known OneMax test function has been chosen. The results are the first to show that a certain class of ant colony optimization algorithms is competitive in runtime complexity with a (1+1) evolutionary algorithm.

The purpose of the paper "Solution bias in ant colony optimization: lessons for selecting pheromone models" by James Montgomery, Marcus Randall, and Tim Hendtlass is twofold. First, new findings bridge biases due to construction with biases in pheromone models. Novel approaches to the prediction of this bias are developed and used with the knapsack and generalized assignment problems. Second, the paper deals with the selection of appropriate pheromone models when detailed knowledge of their biases is not available.

The next three papers deal with evolutionary algorithms. The first one, "Expected runtimes of evolutionary algorithms for the Eulerian cycle problem" by Frank Neumann is a theoretical analysis of evolutionary algorithms with respect to the expected optimization time. Considering the Eulerian cycle problem, they show that a variant of the well-known (1+1) evolutionary algorithm working on the important encoding of permutations is able to find an Eulerian tour of an Eulerian graph in expected polynomial time. The paper "A hybrid approach for multi-objective combinatorial optimization problems in shipping and ship design" by Aykut Olcer describes an evolutionary algorithm for multi-objective combinatorial optimization problems. After giving an overview of the multi-objective combinatorial optimization problems arising in shipping and ship design, a two-stage hybrid approach is proposed for solving a particular problem in ship design, namely the subdivision arrangement of a Ro-Ro vessel. In the first stage, a multi-objective genetic algorithm method is employed to approximate the set of pareto-optimal solutions through an evolutionary optimization process. In the subsequent stage, a higher-level decision-making approach is adopted to rank these solutions from best to worst.

In the contribution "DNA fragment assembly using a grid based genetic algorithm" by Antonio J. Nebro, Gabriel. Luque, Francisco Luna, and Enrique Alba a genetic algorithm for solving the DNA fragment assembly problem in a computational Grid is presented. The algorithm is a steady state GA based on computing parallel function evaluations in an asynchronous way. By using a grid composed of up to 150 computers, the authors have achieved time reductions from tens of days down to a few hours.

0305-0548/$ - see front matter
doi:10.1016/j.cor.2006.12.015

Please cite this article as: Doerner KF, Hartl RF. Computers and Operations Research (2007), doi: 10.1016/j.cor.2006.12.015

In two more contributions particle swarm optimization is applied to solve scheduling problems. Both papers present hybrid variants of particle swarm algorithms with several local search strategies. In the paper "An effective hybrid PSO-based algorithm for flow shop scheduling with limited buffers" by Bo Liu, Ling Wang, and Yi-hui Jin a hybrid algorithm based on particle swarm optimization is proposed for the permutation flow shop scheduling problem with limited buffers between consecutive machines, where the aim is to minimize the maximum completion time (i.e., makespan). The developed particle swarm optimization is hybridized with an efficient population initialization heuristics, ideas from simulated annealing and local search.

The second paper in this group titled "A discrete particle swarm optimization algorithm for the No-Wait flowshop scheduling problem" by Quan-Ke Pan, M. Fatih Tasgetiren, Yun-Chia Liang presents a discrete particle swarm optimization algorithm to solve the no-wait flowshop scheduling problem. The algorithm is hybridized with the variable neighborhood descent algorithm to solve well-known benchmark problems. The computational results show that the developed algorithm provides competitive or better results than those known from the literature.

A new bio-inspired meta-heuristic is presented in the last paper "Viral Systems: a new optimisation approach" coauthored by Pablo Cortés, José M. García, Jesús Muñuzuri and Luis Onieva. It makes use of biological analogy inspired by the performance of viruses. The so-called viral system is applied to Steiner problems for which the optimal solution is known. The method is compared to other metaheuristic algorithms and provides better solutions than genetic algorithms and results comparable to the tabu search algorithms.

Given the range of potential design decisions and applications of bio-inspired search methods, the eight papers presented here can only scratch the surface of this vast research field. We hope that this focused issue will encourage further work in the area of bio-inspired metaheuristics.

Editing a focused issue of Computers and OR would not have been possible without the most valuable input of a large number of people. First of all, we wish to thank all the authors for their contributions. Furthermore, we greatly appreciate the valuable help from the large number of referees. Last but not least we are grateful to the editor-in-chief Professor Gilbert Laporte for his support and assistance.

References

[1] In: Glover F, Kochenberger G, editors. Handbook of Metaheuristics. Boston: Kluwer Academic Publisher; 2003.

Karl F. Doerner
Richard F. Hartl
Department of Management Science, University of Vienna, Bruenner Strasse 72, 1210 Vienna, Austria
E-mail address: karl.doerner@univie.ac.at (K.F. Doerner)

Please cite this article as: Doerner KF, Hartl RF. Computers and Operations Research (2007), doi: 10.1016/j.cor.2006.12.015