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EDITORIAL

Applications of metaheuristics in real-life problems

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The extensive use of computers has raised a large number of real-life optimization problems in different fields that are complex and difficult to solve. Metaheuristics define algorithmic frameworks that can be applied to solve such problems in an approximate way, by combining constructive methods with local and population-based search strategies, as well as strategies for escaping local optima. Metaheuristics present a trade-off between exact methods, which may guarantee an optimal solution, although generally at the expense of a huge amount of computer resources, and greedy methods, which are very fast, but usually provide a low-quality or unsatisfactory solution. Classical metaheuristics, such as Iterated Local Search, Hill Climbing, Genetic Algorithms, Simulated Annealing, TabuSearch and Ant Colony Optimization, have shown their suitability to solve complex scheduling problems, space allocation problems, and clustering problems, among others. The number of metaheuristics is growing and the last years have shown an increasing interest in the scientific community, which has adopted techniques derived from artificial intelligence, operations research, soft-computing, and others. New metaheuristics provide more robust and efficient ways to address traditional optimization problems, and also discover novel ways to attack unsolved problems.

There is not a single metaheuristic that can provide the best results for any kind of optimization problem (what is known as the *No Free Lunch* theorem, as defined by Wolpert and Macready 1996), so practitioners should get familiar with the mechanics of metaheuristics and their scope of application. In this sense, looking at several examples of the applications of metaheuristics can provide the reader hints towards their purpose and their suitability for typical applications. With this perspective, this special issue presents five works that illustrate the application of metaheuristics in real-life problems. They show the use and adaptation of classical metaheuristics, like Genetic Algorithms and Simulated Annealing, or propose some novel metaheuristics to solve global optimization problems.

The first paper, by Mario Rodriguez-Molins, Laura Ingolotti, Federico Barber, Miguel A. Salido, Maria R. Sierra, and Jorge Puente, entitled "A Genetic Algorithm for Robust Berth Allocation and Quay Crane Assignment", deals with dynamic scheduling in a container terminal in a port. The objective is to obtain a schedule of the incoming vessels with an optimum order of vessels mooring and a distribution of the docks and quay cranes for the vessels. The scheduling has to be prepared to adapt to changes that usually happen in this kind of dynamic environment. A robust solution is obtained by introducing the concept of buffer times that should be maximized to absorb possible incidences or breakdowns. Therefore, this problem becomes a multi-objective optimization problem with two opposite objectives: minimizing the total service time and maximizing the robustness of buffer times.

New metaheuristics can result from observation of traditional human practices. For instance, the paper written by Oscar Jose Alejo Machado, Juan Manuel Fernandez Luna, Juan Francisco Huete Guadix, and Eduardo R. Concepcion Morales, entitled "Fisherman Search Procedure", presents a novel metaheuristic inspired in the way a fisherman proceeds to maximize his fishing outcomes. This metaheuristic intends to solve global optimization problems with a combination of guided and local search. It can be parametrized to control its performance and adjust the trade-off between the qual-

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ity of the solution and the resources that the algorithm will require.

The paper written by Tiago P. F. de Lima, Adenilton J. da Silva, Teresa B. Ludermir, and Wilson R. de Oliveira, entitled "An automatic methodology for construction of multi-classier systems based on the combination of selection and fusion", presents a methodology, which is called SFJADE, for the automatic construction of multi-classifiers. This methodology uses self-organizing maps for finding the optimum number of clusters for training data set, and subsequently, in the classification phase, it uses multilayer perceptrons to determine an ensemble for each cluster. The methodology has been successfully applied on data compression of signals generated by artificial nose sensors to classify gases derived from oil, such as propane, butane, methane, and ethane.

Another approach to clustering is presented in the paper "The Parameter-less Randomized Gravitational Clustering Algorithm with on-line Clusters Structure Characterization using Micro-clusters", by Jonatan Gómez, Elizabeth León, Olfa Nasraoui, and Fabian Giraldo. This is a randomized gravitational clustering (RGC) approach, with the characteristic that it does not requires the specification of an initial set of parameters, such as number of clusters, minimum density, or distance threshold. It also combines with a mechanism for representing clusters as sets of prototypes by using micro-clusters. The RGC algorithm will consider the number of cluster fusions produced after each iteration to determine the stopping criteria. The performance of the proposed implementation has been assessed with synthetic and real data sets. The real data sets were five classic machine learning classification data sets, from a case on intrusion detection.

Finally, there is a case of a typical scheduling problem in educational institutions, the determination of the time table at the beginning of the course terms. This is addressed in the work by Nelson Rangel-Valdez, Jorge Omar Jasso-Luna, Mario Humberto Rodriguez-Chavez, and Gustavo Bujano-Guzman, entitled "Practical relaxation of a special case of the Curriculum-Based Course Timetabling problem". This paper shows how to apply a Simulated Annealing-based method to partition this problem into three simpler subproblems, which are the assignment, distribution, and scheduling of the courses. In this way, the search space is considerably reduced, which makes the construction of a solution easier and faster.

These works show the flexibility of metaheuristics, because of their ability to attack many different applications, with diverse requirements. This is accomplished by a combination of methods to explore the search space, escaping from local optima, and determining when good enough solutions have been found. Metaheuristics provide the means to manage the trade-off between performance and quality of solutions. This implies a strong connection of metaheuristics with real-life applications, as they are driven by a pragmatic purpose. The field is quite active nowadays, and we can expect more novel metaheuristics implementations, surely inspired by real-world phenomena and situations.

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