EDITORIAL

Multi-objective metaheuristics for multi-disciplinary engineering applications

Multi-objective optimization arises in many real-world applications, especially in engineering, in which several performance criteria conflict with each other. These conflicting objectives make it probable that no single solution can optimize them all simultaneously. Indeed, the aim of multi-objective optimization is to find a set of compromise solutions with different trade-offs among criteria, also known as the *Pareto optimal set*. When this set is plotted in the objective space, it is called the *Pareto front*.

Many different techniques have been proposed in the multi-objective research community to address multi-objective optimization problems. Unlike classical mathematical programming approaches, metaheuristics have attracted growing attention during the last decade because of their ability to generate several members of the Pareto optimal set in one single run. Metaheuristics are also less sensitive to the shape of the Pareto front so therefore they can deal with a large variety of multi-objective optimization problems. In spite of these advantages, optimization problems coming from the engineering field face metaheuristics with additional challenging tasks such as complex, hardly constrained search spaces, high computational requirements, high dimensionality, etc. These challenges make the research on multi-objective metaheuristics one of the hottest research topics nowadays, raising important funding facilities from national agencies such as *The M* Project* (http://mstar.lcc.uma.es), in which we two Guest Editors are involved.

This Special Issue includes 7 articles out of 21 initial submissions (*i.e.* a 33% acceptance rate). The first contribution, by Yapicioglu and Smith, models the design of the block layout of a retail store as a bi-objective problem in which the revenue generated and the degree of adjacency satisfaction among departments are optimized. This problem has been tacked with a multi-objective tabu search (MOTS), which has been shown to outperform NSGA-II. The authors have also shown that the bi-objective formulation has provided the problem with solutions that improve upon those obtained by the single-objective approach.

The second article, by Guerrero, Berlanga and Molina, formalizes the segmentation of curves in polygonal approximation as a novel multi-objective optimization problem. The application area of this problem is related to many different engineering domains, including planning and manufacturing. The authors have used SPEA2 and compared its results to those of single-objective state-of-the-art techniques on a wide testbed. As in the first contribution to the Special Issue, they have shown the interesting finding that ‘multiobjectivizing’ this problem leads SPEA2 to reach better solutions than single-objective approaches.

System reliability is a major issue for many engineering applications (aeronautics, networks, manufacturing, etc.). A common approach for dealing with such an issue is redundancy, *i.e.* replicating the system components that are critical for its operation. In the third article, Liang and Lo also propose a Variable Neighbourhood Search with a novel archiving strategy based on Pareto optimality for solving redundancy allocation problems with the series–parallel system configuration. Their approach, properly evaluated on a testbed composed of 33 instances, has been shown to outperform 7 state-of-the-art solvers for this problem.

A special case of the multi-objective pick-up and delivery problem taken from a real case of the transportation of persons onto oil platforms is tackled in the fourth article by Velasco *et al*. After a detailed mathematical description and the computation of lower bounds, the NSGA-II algorithm has been used to address both randomly generated and real-world instances of the problem.

The fifth article, by Bong, Lam and Mohd, proposes a multi-objective clustering ensemble method for real-world lung computed tomography (CT) image segmentation. This article contributes with a novel application of a multi-objective scatter search approach to detect lung or pulmonary nodules. This new approach is able to outperform NSGA-II and other classical clustering methods on a wide real-world image dataset.

Texeira *et al.* have developed in the sixth article a multi-objective ant colony optimization (MOACO) algorithm for the twin-screw configuration problem that arises in machines used in the polymer industry (*e.g.* polymer compounding or food processing). This real-world problem lies in locating a set of screw elements in a screw shaft so that two performance measures are optimized. MOACO has been shown to outperform previously developed approaches on 14 case studies that correspond to real laboratory size equipment.

Finally, the article by Aler *et al.* addresses the automatic optimization of the spatial filters used to classify electroencephalogram signals in Brain–Computer Interfaces (BCIs). A novel multi-objective formulation of the problem is proposed in which both the classification rate and the number of attributes for classification are considered. This new multi-objective formulation has been evaluated with four state-of-the-art multi-objective solvers and compared to a single-objective one (with all the attributes available).

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