Guest editorial

Introduction to the special issue on optimisation solutions in systems

Optimisation is a major necessity in science and engineering. No matter if we want to reduce the amount of needed resources to perform a task or maximise the output of some process, so often the difficulty of making the right decisions can be rephrased as some kind of optimisation problem. Unfortunately, for many optimisation problems finding the optimal solution is not feasible in general due to the hardness of the problem; moreover, for some of them we cannot even guarantee any constant ratio between the quality of the optimal solution and the quality of any solution found in reasonable time. Despite these disheartening theoretical limits, optimisation problems appear whenever there is a sophisticated system, so we do have to face them by some means – necessarily non-exhaustive methods. Some of these methods are specific to the problem under consideration, whereas others are adaptations of general optimisation heuristics (metaheuristics) to the studied problem. Typically, the latter search for solutions similar to the most promising observed ones, or their combinations, for example by making some simple entities interact with each other according to simple rules and collaboratively construct new solutions. Within this category we can find evolutionary computation methods and swarm optimisation methods, which are sometimes inspired by some natural process. Regardless of the method selected to tackle a hard optimisation problem, the difficulty of the problem and the performance of the best known heuristics for the problem may have a high impact on the application field the problem belongs to, since the difficulty of a scientific or engineering process can be, to some extent, due to the computational difficulty of the underlying optimisation problem it implicitly poses. The goal of this special issue is to introduce new research on optimisation techniques for engineering systems, and their applications.

The special issue received twelve submissions. Amongst them, six papers were selected for publication. They cover optimisation issues in very different contexts. The first paper, by Acedo *et al.*, deals with the problem of insulin pump therapies in diabetic patients. They monitored diabetic patients recording data every 5 min, analysing their glucose levels, the insulin administered and the estimated amount of ingested carbohydrates. To be able to predict the variation in the glucose levels, a hybrid optimisation technique is used, combining Particle Swarm Optimisation and Nelder-Mead optimisation. The aim of the approach is to improve the insulin dosing by fitting to the concrete model parameters of each patient.

In the second paper, by Dash *et al.*, the optimisation domain is the design of VLSI circuits. In this case, the authors use the River Formation Dynamics metaheuristic to minimise the wire area in large-scale power distribution networks. The usefulness of the approach is assessed by solving several distribution benchmarks, including large examples with several millions of nodes. Observed results are compared against those obtained by using other well-known methods, like Differential Evolution and Particle Swarm Optimisation, showing that the new approach can outperform them.

In the third paper, by Kaaouache *et al.*, the aim is to optimise the energy consumption in Cloud Data Centres. In this case, genetic algorithms are used to assign virtual machines to as few energy-efficient physical machines as possible. By minimising used physical machines (especially during off-peak periods of time), energy can be saved by switching off non-used physical machines. The paper reports the results obtained after simulating the behaviour of a data centre with 800 heterogeneous physical nodes, testing it with different amounts of

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virtual machines. Experiments show that the approach improves the performance of previous methods.

In the fourth paper, Brévilliers *et al.* deal with the camera placement problem, that is, given an area to be observed and given the technical specification of the cameras, the aim is to find the minimum set of locations for this type of cameras allowing full coverage of the area under observation. The authors use a variation of the Differential Evolution metaheuristic to solve this problem, and they compare their results against state-of-the-art approaches, obtaining competitive results.

In the fifth paper, by Lahsinat *et al.*, the optimisation domain is the radio spectrum. More precisely, the minimum interference frequency assignment problem is faced, where given a number of transceivers (and their locations) and given the available frequencies, the aim is to minimise the interferences amongst transceivers by selecting appropriate frequencies for each of them. Lahsinat *et al.* solve the problem by introducing a modified version of Variable Neighbourhood Search, introducing a perturbation mechanism and borrowing ideas from Breakout Local Search. Experiments show that the approach obtains good results when solving a concrete public benchmark.

In the sixth paper, by Ng *et al.*, a multi-objective optimisation method based on stochastic simulation is developed by combining together two optimisation techniques: preference-based guided search (that is, the optimiser guides the search according to his/her preferences) with dynamic resampling (that is, the points to be sampled more times are dynamically chosen). Experiments show that the more stochasticity the simulation models exert, the more the dynamic resampling mechanisms improve the performance of the optimisation process.

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