



# Editorial

The 1990s saw a growing interest in local search, both in the UK and worldwide. For the past decade, operational research practitioners have increasingly found local search to be a useful technique for tackling a wide range of problems. The Local Search Study Group was established within the Operational Research Society in 1999 to provide a forum through which groups of practitioners and researchers can meet. The Study Group covers local search in its broadest sense. Thus, in addition to the classical local search techniques such as simulated annealing, tabu search and genetic algorithms, related methods such as constraint satisfaction and neural networks also lie within the range of interests of the Study Group.

The Local Search Study Group, in collaboration with the Operational Research Society, organized an international Workshop that was held on 16–17 April 2002 at City University, London. The Workshop attracted 50 participants from 12 different countries. The aim of this Workshop was to bring together researchers and practitioners in an informal but supportive environment to discuss current developments and future research directions in local search methods and their applications. The Workshop had diverse streams covering a range of techniques and case studies describing the use of local search in practice.

There were two plenary sessions. Thomas. Stützle (Darmstadt University of Technology) reviewed *ant colony optimization*—a population-based general search technique for the tackling difficult combinatorial optimization problems. He reviewed the ant colony approach and discussed its merits relative to other local search methods. Wim Nuijten (ILOG, France) presented an overview of *constraint satisfaction* and its relationship with local search methods, discussing advantages and disadvantages of constraint programming compared to local search. He also outlined a number of promising new research directions emphasizing the need to solve combinatorial optimization problems in practice.

This issue contains six papers on local search that were presented at the Workshop. We classify the papers into methodology, classical problems (in combinatorial optimization) and applications.

## Methodology

- Reeves and Eremeev study the *solution landscapes* associated with local search algorithms. This is an

important area of research since the insights obtained from the knowledge of solution landscapes can lead to the design of enhanced local search algorithms. This paper uses statistical techniques to estimate the numbers of local optima, and to estimate the probability that a global optimum has been found on the basis of multiple restarts.

## Classical problems

- Bandelt, Maas and Spieksma consider a *multi-index assignment problem*, which is a generalization of the classical linear assignment problem, and has application in the tracking of multiple targets using a single radar. An iterated local search algorithm is developed, which uses a neighbourhood of exponential size that can be searched in polynomial time.
- Levine and Ducatelle develop ant colony optimization algorithms for *bin packing and one-dimensional cutting stock problems*. The proposed ant colony algorithm provides solution of good quality, although a hybrid algorithm that incorporates iterated local search is superior and is competitive with state-of-the-art algorithms.

## Applications

- Archetti and Speranza study a real-world problem in which a fleet of vehicles collects skips that are transported to plants that process the waste. Each vehicle can only carry one skip, and this skip must be taken to a plant that can process the type of waste that it contains. The goal of this *skip collection problem* is to minimize the total of the fixed costs of the vehicles used, the cost of overtime, and penalty costs that are incurred if a customer is not visited. There are numerous side constraints. An algorithm is presented that uses a heuristic to construct an initial solution, and then uses local search in an improvement phase. The solutions obtained with this algorithm are superior to those currently in use.
- McCormick and Powell design a simulated annealing algorithm to produce a *schedule for pumping clean water* to service reservoirs for subsequent distribution to customers. The main decision is which pumps to operate in different periods, which is determined by the energy

costs for pumping, and the requirements to maintain acceptable reservoir levels. The quality of the simulated annealing approach is demonstrated by the closeness of the costs of resulting solutions to the value of a linear programming relaxation of the problem.

- Torres-Velázquez and Estivill-Castro consider a problem that is relevant to the *design of web sites and of distributed database systems*. In both cases, the problem reduces to one of cluster analysis: similarity measures are represented in matrix form, from which it is required to identify clusters. Efficient design of web sites, for example, may require web users to be clustered by frequency of visit to similar websites. The paper shows that the problem reduces to one of finding a *longest Hamiltonian path*. A local search algorithm is shown to perform better than previous widely used methods for this problem.

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