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"*Invention consists in avoiding the constructing of useless contraptions and in constructing the useful combinations which are in infinite minority.*"

Henri Poincaré (1854–1912)

Preface

Combinatorial optimisation is a ubiquitous discipline. Its applications range from telecommunications to logistics, from manufacturing to personnel scheduling, from bioinformatics to management, and a long et cetera. Combinatorial optimisation problems (COPs) are characterised by the need of finding an optimal or quasi-optimal assignment of values to a number of discrete variables, with respect to a certain objective function or to a collection of objective functions. The economical, technological and societal impact of this class of problems is out of question, and has driven the on-going quest for effective solving strategies.

Initial approaches for tackling COPs were based on exact methods, but the intrinsic complexity of most problems in the area make such methods unaffordable for realistic problem instances. Approximate methods have been defined as well as, but in general these are far from practical too, and do not provide a systematic line of attack to deal with COPs. Parameterised complexity algorithms allow efficiently solving certain COPs for which the intrinsic hardness is isolated within an internal structural parameter, whose value can be kept small. For the remaining problems (most COPs actually), practical solving requires the use of metaheuristic approaches such as, evolutionary algorithms, swarm intelligence and local search techniques. Dating back to the last decades of the twentieth century, these methods trade completeness for pragmatic effectiveness, thereby providing probably optimal or quasi-optimal solutions to a plethora of hard COPs.

The application of metaheuristics to COPs is an active field in which new theoretical developments, new algorithmic models, and new application areas are continuously emerging. In this sense, this volume presents recent advances in the area of metaheuristic combinatorial optimisation. The most popular metaheuristic family is evolutionary computation (EC), and as such an important part of the volume deals with EC approaches. However, contributions in this volume are not restricted to EC, and comprise metaheuristics as a whole. Indeed, among the essential lessons learned in the last years, the removal of dogmatic artificial barriers between metaheuristic families has been a key factor for the success of these techniques, and this is also reflected in this book. Most articles in this

collection are extended versions of selected papers from the 7th Conference on Evolutionary Computation and Metaheuristics in Combinatorial Optimization (EvoCOP'2007 – Valencia, Spain). First organised in 2001 and held annually since then, EvoCOP has grown to be a reference event in metaheuristic combinatorial optimisation, with a very strong selection process and high quality contributions each year. This quality is reflected in all contributions comprised here.

The volume is organised in five blocks. The first one is devoted to theoretical developments and methodological issues. In the first paper, Craven addresses a problem in the area of combinatorial group theory, and analyzes the behavior of evolutionary algorithms on it. Ridge and Kudenko deal with an important issue in metaheuristic combinatorial optimization, namely determining whether a problem characteristic affects heuristic performance. They use a design-of-experiments approach for this purpose. Aguirre and Tanaka analyze the behavior of evolutionary algorithms within the well-known framework of NK-landscapes, paying special attention to scalability. Finally, Balaprakash, Birattari and Stüztle propose a principled approach to the design of stochastic local search algorithm, based on a structured engineering-like methodology.

The second block is centered on hybrid metaheuristics. Pirkwieser, Raidl and Puchinger propose a combination of evolutionary algorithms and Lagrangean decomposition, and show its effectiveness on a constrained variant of the spanning tree problem. Nepomuceno, Pinheiro, and Coelho tackle a constrained cutting problem using a master-slave combination of metaheuristics and exact methods based on mathematical programming. Alba and Luque address a problem from sequence analysis using a genetic algorithm that incorporates a specific local search method as evolutionary operator. Finally, Neri, Kotilainen and Vapa use memetic algorithms to train neural networks that are used in turn to locate resources in P2P networks.

The third block focuses specifically on constrained problems. Musliu presents an iterated local search algorithm for finding small-width tree decompositions of constraint graphs. This algorithm is successfully tested on vertex coloring instances. Luna, Alba, Nebro and Pedraza consider a frequency assignment problem in GSM networks. They approach this problem via mutation-based evolutionary algorithms and simulated annealing. Finally, Juhos and van Hemert present some reduction heuristics for the graph coloring problem, and show that these can be used to improve the performance of other solvers for this problem.

The fourth block comprises contributions on the travelling salesman problem (TSP) and routing problems. Firstly, Fischer and Merz describe a strategy for simplifying TSP instances based on fixing some edges, and show that substantial time gains are possible with little or none performance degradation. Subsequently, Manniezzo and Roffilli address a routing problem in the area of waste collection, and compare different metaheuristics on large-scale real-world instances. Labadi, Prins and Reghioui consider a related routing problem too, and propose a memetic algorithm with population management that is shown to be very competitive. Finally, Julstrom consider a facility location problem,

and use an evolutionary algorithm with a permutational decoder for its resolution. The algorithm features different heuristics for reordering elements in the solutions.

Lastly, the fifth block is devoted to scheduling problems. Firstly, Ballestín consider a resource reting problem with time lags, and compare the performance of several metaheuristics. It is shown that some evolutionary metaheuristics can outperform truncated branch-and-bound of this problem. Fernandes and Lourenço tackle job-shop scheduling problems using an algorithm that combines GRASP and branch and bound. The hybrid algorithm compares favorably with other heuristics for this problem. Finally, Xhafa and Durán consider a job scheduling problem in computational grids, and propose the use of parallel memetic algorithms. The results indicate the usefulness of this approach.

We would like to thank all the people who made this volume possible, starting by the authors who contributed the technical content of the book. We also thank Prof. Janusz Kacprzyk for his support to the development of this project. Last, but not least, we thank Dr. Thomas Ditzinger and the editorial staff of Springer for their kind attention and help.

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March 2008 Jano van Hemert

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