Foreword

Combinatorial optimization has a very special place in computer science. On the one hand, this field addresses fundamental problems such as scheduling, resource allocation and vehicule routing, which are central to our economies. On the other hand, combinatorial optimization problems are extremely hard from a computational complexity standpoint: it is very unlikely that an efficient algorithm able to solve all these problems efficiently exists and that a single approach would outperform all others in this field. Different combinatorial problems, or even different instances of the same application, may be solved by very different techniques or by a combination of some of them. Moreover, whatever the approach considered, solving a combinatorial optimization problem usually requires a significant amount of programming and experimentation work.

In this book, Christine Solnon focuses on Ant Colony Optimization (ACO), a relatively recent approach for solving combinatorial problems. The topic is relevant: during the last decade, ACO has gradually evolved from an intellectual curiosity to a metaheuristic that has obtained outstanding results on some applications. This is the case, for example, of scheduling in assembly lines: a particularly difficult application for which ACO is able to solve a large class of instances with a very impressive efficiency and success rate. The scientific article published by the author on this subject was, indeed, a true revelation for many researchers.

However, this book does not introduce ACO in an isolated way, but provides an overview of many approaches. The first part of the book provides a short but excellent summary of the state of the art, with a focus on constraint satisfaction problems. Not only does this presentation clearly identify ACO

contributions, but it also highlights the similarities, differences and synergies between existing approaches and ACO. Indeed, a truly innovative contribution of this book is to show how ACO compares to approaches as varied as greedy algorithms, local search and constraint programming.

The second part is a very didactic presentation of ACO. It shows us that ACO is a metaheuristic which produces collective intelligence from individual behaviors and local interactions. It provides an intuitive presentation of the various ACO components and a detailed overview of diversification and intensification mechanisms used by ants to sample the search space and converge towards the best solutions.

The book is organized around a broad vision of constraint programming: the idea that constraint programming defines the combinatorial structure of an application in a declarative way, and that this structure can be exploited by different solution algorithms. This view allows the author to communicate the benefits of ACO in a much more general way than the existing literature; the last part of the book is a good illustration of this. The application chapters are a goldmine for readers interested in acquiring a deep understanding of ACO. The last chapter provides a glimpse of the future of this metaheuristic and allows us to imagine many other connections.

In brief, Christine Solnon has written an effective book which targets both students and researchers wishing to acquire a thorough knowledge of the principles underlying ACO as well as industrialists in search of new solutions for their combinatorial optimization problems. It also communicates a comprehensive approach for solving combinatorial problems based on constraint programming, and allows us to establish judicious connections between several areas. This book is short, well written and full of ideas. It makes us curious to learn even more.

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