Preface

Half a century ago Harold W. Kuhn published two famous articles presenting the Hungarian algorithm, the first polynomial-time method for the assignment problem. This historic result allowed for the first time an easy solution of real-world instances that no computer on earth could then handle. The Hungarian algorithm and other fundamental results on integer and linear programming, obtained in the same years, gave birth to an exciting new research area, today known as combinatorial optimization. Over the next fifty years the assignment problem, its linear variations, and its quadratic counterpart have attracted hundreds of researchers, accompanying and sometimes anticipating the development of combinatorial optimization.

This volume presents a comprehensive view of this huge area, starting from the conceptual foundations laid down since the 1920s by the studies on matching problems, and examining in detail theoretical, algorithmic, and practical developments of the various assignment problems. Although the covered area is wide, each of the ten chapters is essentially self contained, and the readers can easily follow a single chapter in which they are interested by encountering a few pointers to the essential background given in previous parts.

This book has been developed with the ambition of providing useful instruments to a variety of users: researchers, practitioners, teachers, and students.

Researchers will find an up-to-date detailed exposition of the theoretical and algorithmic state of the art, not only of the basic linear sum assignment problem but also of its many variations, for which there is plenty of room for improvements: bottleneck, algebraic, balanced, quadratic, and multi-index assignment problems are promising areas for new investigations. In particular, the quadratic assignment problem still lacks effective exact solution methods: after decades of investigations, instances of size 30 require CPU *years* to be solved to optimality. Although this problem is $\mathcal{NP}$-hard, such results could indicate that its combinatorial structure has not yet been fully understood.

Practitioners need clear expositions of successful applications, information on the practical performance of exact and heuristic algorithms, and pointers to high quality software. Almost all of the chapters have one or more sections devoted to the description of real-world situations managed through the described methodologies. The experimental behavior of various algorithms is examined on the basis of computational experiments. The associated home page, http://www.siam.org/books/ot106/assignmentproblems.html, makes available a number of efficient computer codes, either through direct downloads or through links.

Teachers and students will have a potential textbook for advanced courses in discrete mathematics, integer programming, combinatorial optimization, and algorithmic computer

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science. The theoretical background of each argument is presented in a rigorous way. The algorithms are introduced through an intuitive explanation of their essential features. In most cases, the presentation is completed by a detailed pseudo-code implementation. The main algorithmic techniques are illustrated through a number of exercises presented in the form of fully-developed numerical examples. A further didactic tool is provided by the applets available on the associated home page, which allow step-by-step execution of some basic algorithms.

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