Handbook of Combinatorial Optimization

Supplement Volume A

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Contents

Preface

Combinatorial (or discrete) optimization is one of the most active fields in the interface of operations research, computer science, and applied mathematics. Combinatorial optimization problems arise in various applications, including communications network design, VLSI design, machine vision, airline crew scheduling, corporate planning, computer-aided design and manufacturing, database query design, cellular telephone frequency assignment, constraint directed reasoning, and computational biology. Furthermore, combinatorial optimization problems occur in many diverse areas such as linear and integer programming, graph theory, artificial intelligence, and number theory. All these problems, when formulated mathematically as the minimization or maximization of a certain function defined on some domain, have a commonality of discreteness.

Historically, combinatorial optimization starts with linear programming. Linear programming has an entire range of important applications including production planning and distribution, personnel assignment, finance, allocation of economic resources, circuit simulation, and control systems. Leonid Kantorovich and Tjalling Koopmans received the Nobel Prize (1975) for their work on the optimal allocation of resources. Two important discoveries, the ellipsoid method (1979) and interior point approaches (1984) both provide polynomial time algorithms for linear programming. These algorithms have had a profound effect in combinatorial optimization. Many polynomial-time solvable combinatorial optimization problems are special cases of linear programming (e.g. matching and maximum flow). In addition, linear programming relaxations are often the basis for many approximation algorithms for solving NP-hard problems (e.g. dual heuristics).

Two other developments with a great effect on combinatorial optimization are the design of efficient integer programming software and the availability of parallel computers. In the last decade, the use of integer programming models has changed and increased dramatically. Two decades ago, only problems with up to 100 integer variables could be solved in a computer. Today we can solve problems to optimality with thousands of integer variables. Furthermore, we can compute provably good approximate solutions to problems with millions of integer variables. These advances have been made possible by developments in hardware, software and algorithm design.

The Handbook of Combinatorial Optimization deals with several algorithmic approaches for discrete problems as well as with many combinatorial problems. We have tried to bring together almost every aspect of this enormous field with emphasis on recent developments. Each chapter in the Handbook is essentially expository in nature, but of scholarly treatment.

The Handbook of Combinatorial Optimization is addressed not only to researchers in discrete optimization, but to all scientists in various disciplines who use combinatorial optimization methods to solve problems. We are certain that experts in the field as well as nonspecialist readers will find the material of the Handbook stimulating and helpful.

We would like to take this opportunity to thank the authors, the anonymous referees, and the publisher for helping us produce these volumes of the Handbook of Combinatorial Optimization with state-of-the-art chapters. We would also like to thank Ms. Xiuzhen Cheng for making the Author Index and the Subject Index for this volume.

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