students to a mathematical viewpoint or to a mathematics course with a secondary goal of exposing students to a computer science viewpoint. It may not be quite the right book for some operations research curricula in that the book contains practically no mathematical programming. However, it might serve an OR department very well if paired with a linear/integer programming course. I imagine it might also work well in a course in which students are implementing algorithms (because of the pidgin-PASCAL style), if supplemented with discussions of data structures. The book contains a large number of interesting problems including extensive hints and solutions in an appendix.

The book begins with two introductory chapters, each about 30pp. The first addresses the basics of graph theory. The second chapter addresses the basics of algorithms: what is an algorithm, how do you represent graphs with data structures, how do you write an algorithm in pidgin PASCAL, and complexity. The second chapter includes a quick introduction to NP-completeness and contains a proof that the hamiltonian cycle problem is NP-complete. Both set the groundwork nicely for the rest of the book.

The next two chapters address shortest paths and spanning trees, respectively. All the basics are there, as you'd expect. However, the shortest path chapter ends with a section on path algebras and the spanning tree chapter ends with sections on Steiner trees, spanning trees with restrictions, and arborescences and directed Euler tours. These are topics not typically found in introductory texts. They can easily be skipped, but they are great for showing students how the basic ideas can be generalized and extended; in short, how research is often done.

Subsequent chapters follow this same pattern of covering the basics followed by a quick foray into more advanced topics. For example, Chapter 5 is devoted to the greedy algorithm and the basics of matroids are introduced, as expected. But the chapter also includes a discussion of using the greedy algorithm for approximations as well as a surprising and interesting section on accessible set systems, containing work mostly from the 1990s, again demonstrating that new questions are not far away.

Subsequent chapters address flows, applications (of flows) in combinatorics (e.g., Menger's theorem), colorings, circulations, network synthesis, connectivity, matchings, weighted matchings, and the traveling salesman problem. A weakness of the style adopted in this book appears in the presentation of Edmonds' cardinality matching algorithm. This is typically a difficult topic and I don't think the pidgin-PASCAL style works well. It seems easy to get lost in the minutia of the algorithm at the expense of seeing the big picture. The weighted matching problem is addressed only for the bipartite case. It is followed by a quick taste of the related integer programming-style results, with references to some books taking this different approach. The weighted matching algorithm for general graphs is only hinted at. Without access to the techniques of mathematical programming, this makes good sense. The final chapter on the traveling salesman problem is the main diversion from polynomial algorithms and serves as a nice introduction to how hard problems can be dealt with.

In summary, I think Jungnickel has written a solid book that can be used in a variety of courses and in a variety of ways; it may be just what many instructors are looking for.

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Paolo Toth and Daniele Vigo (editors) *The, vehicle routing problem*, Monographs on Discrete Mathematics and Applications 9, SIAM, Philadelphia, PA, 2001, ISBN 0-89871-498-2, 367 pp., $102.

Every so often, a book appears which attempts to present the state-of-the-art in both theory and solution approaches for a specific combinatorial optimization problem. In the 1980s, for example, we had the celebrated book on the TSP edited by Lawler et al. [6], the fine text on matching theory by Lovász and Plummer [7], and the volume on vehicle routing edited by Golden and Assad [3]. More recently, we have the volume on arc routing edited by Dror [2], another book on the TSP edited by Gutin and Punnen [5], and this new book on vehicle routing edited by Toth and Vigo.

Apart from the initial introductory chapter, the book is divided into three main sections. The first section deals with the classical VRP with capacity restrictions only. Five chapters cover branch-and-bound, branch-and-cut, column generation, classical heuristics, and meta-heuristics, in that order. I found it interesting to see that the exact methods have been placed before the heuristics. Perhaps, this is a sign of how far exact methods have come in the past few decades. The second section, which consists of only three chapters, is concerned with some important variations of the VRP, namely, the VRP with time windows, the VRP with backhauls, and the VRP with pickup and delivery. The third and last section gives some case studies taken from practical applications, and includes a brief chapter (a little too brief, in my opinion) on commercial software.

All chapters are extremely well written and comprehensive. The nice thing is that a common notation and terminology is used throughout, which makes the book seem unified despite having nearly thirty authors. This common notation extends to the naming scheme for VRP instances presented on p. 22, which I think should become the standard from now on. The book is also almost completely free from typos, although there are a few (e.g., "tenths" instead of "tens" on p. 22; "loosing" instead of "losing" on p. 38).

I'm not sure exactly what the intended audience of the book is, but it would make an excellent reference work for post-doctoral researchers working in the field of combinatorial optimization. It would also be highly useful for graduate and doctoral students who are about to embark on research in this field, although the students would first need a knowledge of the basic concepts of mathematical programming: linear programming, cutting planes, branch-and-bound, duality, relaxation, heuristics, and so on.

Of course, the literature on vehicle routing is by now so vast that it would be impossible to cover everything in a single volume. Therefore, it will come as no surprise that there are some notable omissions. With respect to problem variants, there is little or no mention of the VRP with unit demands, the VRP with time deadlines, or the mixed fleet VRP. Also, a few very nice papers are overlooked, such as the one by Araque [1], in which comb inequalities are presented which dominate those found on p. 65 of the book; and the one by Gouveia [4], which implicitly presents the first polynomial-time separation algorithm for an important class of multistar inequalities. Finally, there have been some interesting recent developments in the use of constraint programming to solve the TSP with time windows, and also for solving the column generation subproblem for the VRP with time windows, but these have not made their way into the book.

Despite this minor criticism, however, I think that this is an extremely nice book, and, by academic standards, it is reasonably priced at $102. It has made a very welcome addition to my bookshelf.

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