Applegate, David L., Robert E. Bixby, Vašek Chvátal, William J. Cook. The Traveling Salesman Problem: A Computational Study. Princeton UP, Princeton. 606 pp. $45.00.

The symmetric traveling salesman problem (TSP) is one of the best-known problems of combinatorial optimisation, very easy to explain and visualise, yet with a semblance of real-world applicability. Given a set of points, the cost of moving between each two in either direction, and a constant k, the task in the TSP is to decide, whether it is possible to visit all points, each one exactly once, and to return back to the point of departure, at a total cost of no more than k. The latest book by Applegate, Bixby, Chvátal, and Cook provides an excellent survey of methods that kick-started this "engine of discovery in applied mathematics" (invoked on pp. 40-43, 56, 59, 489, and 531).

In more than 600 pages, the authors present a survey of methods used in their present-best TSP solver Concorde, almost to the exclusion of any other content. Chapters 1–4 describe the TSP and Chapters 5–6 provide a brief introduction to solving the TSP by using the branch and cut method. At the heart of the book are then Chapters 7–11, which survey various classes of cuts, in some cases first proposed by the authors themselves. Chapter 7 surveys cuts from blossoms and blocks, Chapter 8 presents cuts from combs and consecutive ones, and Chapter 9 introduces cuts from dominoes. Chapters 11 and 12 then describe in yet more detail separation and metamorphoses of strong valid inequalities. Other variants of the problem, such as the asymmetric TSP, and other solution approaches, including metaheuristics and approximation algorithms, are mentioned only in the passing. They are, however, well-covered elsewhere (Gutin & Punnen, 2002), and the seemingly narrow focus consequently enables the authors to provide an outstandingly in-depth treatment.

The treatment especially benefits from authors' extensive experience with implementation of solvers for problems of combinatorial optimisation. In many textbooks on combinatorial optimisation, primal heuristics are mentioned only in passing and cuts are presented in the very mathematical style of definition – proof of validity – proof of dimensionality. Not here. Chapter 6-11 suggest separation routines, exact or heuristic, alongside the description of strong valid inequalities, Chapter 12 is devoted to management of cuts and instances of linear programming, Chapter 13 describes pricing routines for column generation, and last but not least, Chapter 15 is devoted to primal (tour-finding) heuristics. "Implementation details", such as the choice of suitable data structures and trade-offs between heuristic and exact separation, are thus thoroughly discussed. This emphasis on computational aspects of combinatorial optimisation should be certainly commended and recommended.

Perhaps surprisingly for a book subtitled "a computational study", a large part of the book (Chapters 1–4, parts of Chapters 13–17) is devoted to the history of exact methods in combinatorial optimisation, in general, and in solving the TSP, in particular. These parts also provide an excellent commentary to a bibliography of 561 items. Although the excitement clearly visible in these parts of the book is also manifested in other accounts of "research by competition", this *histoire* certainly ranks among the best in "motivational history of mathematics".

Finally, the editorial attitudes reflected in this book should be lauded. The text is based on experiences the authors gained while developing Concorde, which is freely available at `http://www.tsp.gatech.edu`. All observations and conclusions are thus easily verifiable and any details can be looked up in the source code. Such a level of integrity has recently been seen only regrettably seldom, although there are exceptions including SCIP, the integer programming solver by Tobias Achterberg (Achterberg, 2007), and SAT solvers, such as Chaff (Moskewicz et al., 2001) and PicoSAT. Little comparison with other approaches is given, but this can well be explained by the unrivalled performance of Concorde. The text is very well written and is accompanied by a number of illustrations and illustrative examples, as one would expect from Vašek Chvátal (Avis et al., 2007) and Bill Cook. Also the type-setting (outside of Chapter 11), book-binding and reasonable pricing can well be lauded. These often overlooked technical aspects of book writing and production contribute to the pleasure one derives from reading this great book.

Although narrow in scope, the book can be recommended to a surprisingly wide audience – most likely to any researcher working in combinatorial optimisation. Advanced undergraduate students and anyone else with a keen interest in combinatorial optimisation and advanced algorithm design may also enjoy reading this book.

References

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