Operations Research Letters 38 (2010) 240

Contents lists available at ScienceDirect

Operations Research Letters

journal homepage: www.elsevier.com/locate/orl

Book review

Rainer Burkard, Mauro Dell'Amico, Silvano Martello. *Assignment Problems*, SIAM, 2009, ISBN: 978-0-898716-63-4, 382 pp., $110.

If ever there is a single problem that signifies the success of combinatorial optimization, it is the assignment problem. Solving the problem to optimality is not obvious, and an ingenious method was developed by Harold Kuhn, in the 1950s. This method, called the Hungarian method, has been celebrated during a symposium in Budapest in October 2005, and can safely count as a fundamental pillar, or even count as the beginning of the field we know as combinatorial optimization. In an unexpected twist of history, it has recently been found that the famous mathematician Carl Gustav Jacob Jacobi (1804–1851) already designed a Hungarian-like, polynomial-time method for the assignment problem; see "Looking for the order of a system of arbitrary ordinary differential equations" by Jacobi, translated into English by Francois Ollivier, that appeared in 2009 in the journal *Applicable Algebra in Engineering, Communication and Computing*, volume 20, pages 7–32.

So, yes, the assignment problem definitely deserves a book. And did the problem get the book it deserves? Again, yes. The authors have written an impressive, very well-documented, accessible monograph. The book has a very strong algorithmic flavor. Many different algorithms for the assignment problem are described in great detail (in pseudo-code), and those descriptions are accompanied by numerical examples further explaining the method. The book gives many theorems as well as their proofs. It also contains applications of assignment problems and its variations, both in traditional and less traditional domains. The book is also ambitious; from the preface I quote "…providing useful instruments to a variety of users: researchers, practitioners, teachers, and students". After discussing the contents of the book, I will come back to this goal.

The book has ten chapters. After an introductory chapter, the book starts off with perfect matchings in bipartite graphs (Chapter 2), and bipartite matching algorithms (Chapter 3). The core of the book is Chapter 4, which gives extensive descriptions of various algorithms for the assignment problem. Of course, it describes the Hungarian algorithm, and it further gives the Dinic–Kronrod algorithm, primal algorithms (simplex-based and non-simplex), and dual algorithms (among which are the signature method, auction algorithms, and pseudoflow algorithms). This chapter ends with an experimental analysis describing the computational performances of different codes on different sets of instances. Chapters 5 and 6 deal with the many different variants of the assignment problem (random cost coefficients, the bottleneck assignment problem, the balanced assignment problem, and others), and discuss the algorithmic consequences. Chapters 7, 8, and 9 deal with quadratic assignment problems. This problem is a generalization of the assignment problem, and is, in fact, NP-hard. Thus, heuristics and, in particular, metaheuristic methods become relevant, and Chapter 8 deals with such approaches. The last chapter, Chapter 10, is devoted to yet another generalization of the assignment problem, namely the multi-index (or multidimensional) assignment problems. Again, this is a very readable chapter, explaining the two forms of the three-index assignment problem (axial and planar) using insightful figures, before going on to describe the general case.

The book is very well-documented. It has an index as well as an author index, and each of the 669 references in the bibliography refers back to the page in the book where the reference was made. In addition to the book there is a webpage where not only is there a list of errata, but also various software programs can be downloaded for free.

In my experience, it is not a book that should be read starting on page 1 and ending on page 382. Rather, when being confronted with some kind of assignment-like problem, looking up the appropriate pages will leave you better informed than you were before, and may even leave you impressed by the huge effort that the authors must have invested to collect, assemble, and unify all these asssignment-related results.

Are there no mistakes at all, then? I could only find a very few errors. On page 189, there is a reference to "Camerini [170]" that does not appear to be present in the bibliography. Also, I managed to find a statement in Chapter 10 that is not quite accurate: "…which yield a feasible solution whose value is not worse than 3/2 of the optimal value in the first case, and 4/3 of the optimal value in the second case." That should actually be "which yield a feasible solution whose value is not worse than 4/3 of the optimal value in *both* cases". This, indeed, is a detail.

So, does the book achieve its goal? I think it does. Without a doubt, the book is interesting for researchers as a source of results and their proofs, and as a source of references. Also, teachers and students will find the book useful for finding, for instance, clear explanations of various algorithms. For practitioners, the webpage and also the section on experimental analysis are relevant. The book is a remarkable achievement.

Frits C.R. Spieksma
Katholieke Universiteit Leuven, Faculty of Business and Economics, Naamsestraat 69, B-3000Leuven, Belgium
E-mail address: frits.spieksma@econ.kuleuven.be.

Available online 18 February 2010

0167-6377/$ – see front matter
doi:10.1016/j.orl.2010.02.001