Book Review

P. Pardalos and H. Wolkowicz (eds.): *Quadratic Assignment and Related Problems*. DIMACS Series in Discrete Mathematics and Theoretical Computer Science Vol.16. American Mathematical Society, 1994, ISBN 0-8218-6607-9.

Among combinatorial optimization problems with practical relevance, the quadratic assignment problem (QAP) plays an outstanding role. The QAP has far reaching applications in location theory, scheduling, manufactoring, parallel and distributed computing, data analysis, theoretical chemistry and in many other areas. In spite of this huge practical interest, it is even nowadays not possible to solve instances with size $n > 20$ optimally. In order to stimulate further research in QAPs and their solution, a DIMACS Workshop on Quadratic Assignment and Related Problems organised by Pardalos and Wolkowicz was held in May 1993. The volume in hand reflects the contributions delivered at this workshop and rounds the topic by a survey on the state of the art and some additional articles in this field. Thus this volume becomes a valuable source on QAPs.

The book contains in total 17 articles. It starts with a survey of Pardalos, Rendl and Wolkowicz on recent developments in this field. In particular, eigenvalue based bounds are treated, complexity issues are discussed and solution methods are reviewed. This survey ends with a bibliography on QAPs with more than 250 entries. The difficulties for solving QAPs are shown in an article by Mautor and Roucairol. The main reason is the weakness of the known lower bounds. Mautor and Roucairol suggest several improvements in branch and bound procedures and design a new parallel branch and bound method for QAPs.

As mentioned above the determination of strong lower bounds is one of the crucial points in solving QAPs. Several contributions are devoted to new suggestions in this direction. Adams and Johnson consider a new mixed integer formulation of QAPs and devise a dual ascent strategy for computing "good-quality" dual feasible solution and associated bounds. Another general lower bounding procedure is described by Carraresi and Malucelli. Chakrapani and Skorin-Kapov transform a given QAP into a pair of related QAPs: one for which an optimal solution is known and a residual one. This method could serve to possibly tighten existing bounds. Two other lower bounding techniques are suggested by Hadley. Both proved to be not very successful during computational tests and the author makes an effort to explain the poor behavior. Finally, Karisch, Rendl and Wolkowicz present a trust region approach for general quadratic matrix minimization problems with orthog-

onal constraints. They obtain numerical results by using a parametric eigenvalue technique.

Another mainstream of papers concerns the development of good heuristics. Li, Pardalos and Resende present a greedy randomized adaptive search procedure (GRASP) for the QAP and report on computational experience with a large set of test problems. Fleurent and Ferland combine genetic operators with existing heuristics in order to get another heuristic which performs well. The book contains also severall heuristics for related problems. Thang Nguyen Bui and Byung Ro Moon describe a genetic algorithm for graph bisection. Areibi and Vannelli combine tabu search with features from genetic algorithms in order to approach the circuit partitioning problem which occurs in circuit layout and VLSI design.

This leads us to the third group of papers which are concerned with generalisations, spezialisations and applications of QAPs. A generalisation of the QAP, the so-called biquadratic assignment problem which is motivated by VLSI design, is described by Burkard, Çela and Klinz. They design lower bounds and analyze the asymptotic behaviour of this class of problems. They show that the ratio between best and worst objective function values tends in probability to one when the size of the problem tends to infinity. Wu-ji Li and Macgregor Smith model stochastic congestion within layout models by QAPs and related problems. Medova discusses communication network design problems and analyzes QAP-based bounds for the circulant travelling salesman problem. Sherali and Brown describe a quadratic partial assignment problem and packing model and its application to the airline gate assignment problem. This problem seeks to allocate gates to aircraft with the objective to minimizing passenger walking distances. A suitable heuristic solution procedure is proposed.

Finally, two papers are concerned with an analysis of data sets. Mirkin considers the approximation of association data by structures and clusters, whereas Poore and Rijavec consider multidimensional assignments for partitioning multiple data sets.

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