Book Review

Katta G. Murty, *Operations Research: Deterministic Optimization Models.*

This book is designed to be used as a text in an undergraduate or an elementary introductory graduate course that deals with an array of deterministic optimization models and techniques, as opposed to focusing on a few topics such as linear programming, nonlinear programming, or dynamic programming. The discussion in each chapter concentrates on the basic fundamental principles, and illustrates them using interesting examples. Each chapter is accompanied by an extensive set of educational exercises, and a selected set of references for further study. A useful glossary of notation is also provided.

The book is organized into 14 chapters. Chapter 1 begins with an introduction into constructing optimization models and their value in practice. Chapter 2 continues this discussion in the context of linear programming, providing a set of illustrative model constructions for a variety of different problems. Chapter 3 gives a useful review of linear algebra and basic geometric constructs. Chapter 4 develops duality concepts and optimality conditions for linear programming problems. A discussion of marginal values in nondegenerate situations is also provided. This section might have benefited by a discussion on existing post-optimality analysis packages such as the ones being developed by Harvey Greenberg and Frederick Murphy. Chapter 5 presents a discussion on the Hungarian primal-dual approach for solving linear assignment problems. In contrast with other textbooks of this scope, Murty nicely presents the polynomial $O(n^4)$ variant of this method, mentioning that a modification is operable with complexity $O(n^3)$. Chapter 6 deals with the transportation problem, and this time, presents a primal simplex approach for solving this network flow problem. Practical sensitivity analysis issues as well as a discussion on alternative optimal solutions and the treatment of sensitivity analysis is provided, including the ranging of objective, right-hand side, and constraint coefficients. Chapter 8 deals with the treatment of multiobjective models, focusing on the non-preemptive weighting approach, and the goal programming approach of using penalty functions to attain specified goals or targets. Chapters 9 through 11 deal with combinatorial optimization problems. In Chapter 9, the focus is on constructing models for integer programming problems. Some interesting 0–1 feasibility examples adapted from Smullyan's (1978) book are presented along with other illustrations. However, the discussion does not progress to the level of

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constructing "good" models that possess tight linear programming relaxations – for example, the aggregated, rather than the disaggregated, model for the plant location problem is presented. Chapter 10 deals with the basic elements of branch and bound methods, discussing the concepts of branching or partitioning, bounding, and fathoming. Chapter 11 then discusses various heuristic approaches for combinatorial optimization problems. The general principles of the greedy heuristic approach are presented along with illustrations using set covering, travelling salesman, and vehicle routing problems. The interchange heuristic is discussed along with an illustration on a location problem, simulated annealing concepts are presented and illustrated on the travelling salesman problem, and a discussion of the fundamental ideas in genetic algorithms are presented. Chapter 12 deals with discrete deterministic dynamic programming problems, and illustrates this technique on general integer and 0–1 knapsack problems, the shortest path problem, and resource allocation problems. The related, practically useful, discussion on critical path methods CPM is given in Chapter 13. Concepts of early and late start and finish times, and the slack/float in each activity along with concepts of critical paths are described in detail. Finally, Chapter 14 deals with nonlinear programming problems. The chapter begins with an introduction to convexity ideas and presents the superdiagonalization method for checking definiteness. Local and global optimality concepts, and the intractability of verifying local optimality of a stationary point are briefly discussed. First- and second-order necessary and sufficient conditions are then stated and illustrated with examples for unconstrained, linearly constrained, and under the linear independence constraint qualification, for nonlinearly (inequality and equality) constrained problems. Practical line search methods such as Armijo's inexact line search and the quadratic fit line search method are presented. The Newton–Raphson method for solving nonlinear equations is also described. The BFGS quasi-Newton method for unconstrained minimization is discussed next and the chapter closes with the presentation of penalty function concepts.

Overall, this book gives a good quick overview of deterministic optimization models and techniques, inducing the reader to pursue this subject in further study. The principal focus is on basic concepts and methodologies, and these are well illustrated using numerous examples.

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