Chapters 1 through 6 form the first part. The emphasis is on finding "local" minimizers using local differential information, explicitly in the form of separately computed gradients, or implicitly by utilizing difference information. The thorny problem of determining "global" minimizers is only occasionally mentioned. Chapter 1 contains introductory material. The important Chapter 2 surveys the general structure of the methods and pays well-placed attention to the principles and algorithms for "line search", a feature in many of the subsequently discussed methods. Chapters 3 and 4 on Newton, quasi-Newton, and conjugate gradient methods form the core of the first part on unconstrained optimization. The final two chapters round out that material, featuring among others: trust regions, Levenberg-Marquardt techniques, the Newton-Raphson method and Davidenko continuation methods for solving systems of nonlinear equations, the theory of superlinear convergence.

Chapters 7 through 14 form the second part. Here "constrained optimization" is first and foremost the optimization of functions, generally excluding the large field of combinatorial optimization. Chapter 7 is again introductory. Chapter 8 features linear programming with emphasis on the simplex method and some of its variations such as "product form" and LU-factoring of the basis and Dantzig-Wolfe decomposition. Lagrange multipliers, first- and second-order optimality conditions, convexity and duality are introduced in Chapter 9 preparatory to the description of classical nonlinear programming in Chapters 10 through 12: quadratic programming, linearly constrained optimization, zigzagging, penalty and barrier functions, sequential quadratic programming, feasible directions. Integer programming is only briefly discussed, stressing branch-and-bound techniques. It shares Chapter 13 with sections on geometric programming and optimal flows in networks. The final Chapter 14 offers a unique self-contained treatment of nondifferentiable or, rather, piecewise differentiable optimization.

The book is a classic and invaluable for the practitioner as well as the student of the field.

CHRISTOPH WITZGALL

Center for Computing and Applied Mathematics
National Institute of Standards and Technology
Gaithersburg, Maryland 20899

1. R. FLETCHER, *Practical Methods of Optimization, Vol.* 1: *Unconstrained Optimization*, Wiley, Chichester, 1980.

2. R. FLETCHER, *Practical Methods of Optimization, Vol.* 2: *Constrained Optimization*, Wiley, Chichester, 1981.

27[90–01, 90B99].—PANOS Y. PAPALAMBROS & DOUGLASS J. WILDE, *Principles of Optimal Design—Modeling and Computation*, Cambridge Univ. Press, Cambridge, 1988, xxi+416 pp., 26 cm. Price $49.50.

For anyone interested in modeling, model building, and in particular, optimization models and the interaction between optimization and the modeling process, this book is a must. It combines classical optimization theory with new ideas of monotonicity and model boundedness that provide valuable information for determining the most efficient and correct formulation of a model. It is an easy-to-read book with clear, modern notation, well-drawn graphs, and an easy-to-follow organization. It contains just enough theory and proofs to be complete, without being overburdened, and follows each concept with examples, applications, and realistically designed engineering design problems. Although aimed at the engineering design student, it is a valuable addition to the libraries of operations researchers, economists, numerical analysts, and computer scientists. The engineering flavor might at first be discouraging, but the discomfort quickly vanishes as the down-to-earth treatment of the topics comes through.

There are eight chapters in the book. Each has a concise introduction to set the stage for the concepts to be presented, and a summary to tie all the ideas together and reinforce what was introduced. The chapters are organized so as to create in the reader an appreciation for models, from their definition to their use.

Chapter 1 is an excellent introduction to mathematical modeling and the different types of models. It defines the design optimization problem and most of the other ideas and issues that are addressed throughout the book, including feasibility and boundedness, design space topography, data modeling, solution, and computation. The concept of a "good" model is introduced (one that represents reality in a simple but meaningful manner), and the limitations of modeling are also touched on.

The second chapter, on model boundedness, introduces the concepts of verification and simplification, which all too often are overlooked in modeling literature and practice. The authors stress the importance of applying the techniques of this chapter *before* performing any detailed computation, and note that in so doing, one obtains reductions in model size, tighter formulations, more robust models, and even formulation error detection. In this, the authors could not be more correct. As computers and computing become cheaper and more powerful, more researchers are relying on modeling and computational experiments to test new ideas. Problems which could not be solved before are now being addressed with success. The ideas introduced in this chapter are critical to this process and are the same ones used so successfully, for example, to solve large-scale integer programming problems. (See, e.g., [1], [2].)

Chapter 3, on interior optima, provides the mathematical foundation for local iterative methods. Its concise treatment is especially useful for those who want not only to understand the theory but also to use the methods to solve problems. Optimality conditions are presented here, along with convexity, gradient methods, Newton-type methods, and stabilization using modified Cholesky factorization. Unfortunately, there is no discussion about interior point methods for solving linear programming problems.

Boundary optima are the subject of Chapter 4. The discussion proceeds from feasible directions to sensitivity analysis. Also included are discussions of reduced gradients, Lagrange multipliers, the generalized reduced gradient method, gradient projection, and Karush-Kuhn-Tucker conditions. After the general case is treated, linear programming is developed at the end of the chapter, an approach I found appealing.

In Chapter 5, on model reduction, the ideas from Chapters 2, 3, and 4 are combined into a well-developed approach to the idea of producing as tight a formulation as is possible. Two new concepts are introduced to help in this search for a minimal formulation, a rigorous Maximal Activity Principle, and a heuristic Coincidence Rule. I found this theoretical approach to model reduction very appealing.

Global bound construction, the topic of Chapter 6, is the logical next step in the progression toward developing useful models. Constructing tight bounds, as the authors note, not only saves effort, but avoids accepting suboptimal solutions. Many techniques for constructing bounds are introduced here, from simple lower bounds to geometric inequalities, to unconstrained geometric programming. Combining these techniques into a process for model reduction using branch and bound is also discussed.

Chapter 7, on local computation, contains descriptions of various numerical algorithms for solving nonlinear programming problems. It is introduced with a brief section on choosing a method from among the large number of generally accepted techniques that are available. It contains sections on convergence, termination criteria, single variable minimization, Quasi-Newton methods, differencing, scaling, active set strategies, and Penalty and Barrier methods.

The real action is in Chapter 8, Principles and Practice. It begins with a review of the modeling techniques and approaches presented in the previous chapters. The goal is "to point out again the intimacy between modeling and computation that was explored first in Chapter 1." An optimization checklist is also provided for the novice modeler to use as a prompt while gaining more experience.

RICHARD H. F. JACKSON

Center for Manufacturing Engineering
National Institute of Standards and Technology
Gaithersburg, Maryland 20899

1. K. L. HOFFMAN & M. W. PADBERG, *Techniques for Improving the Linear Programming Representation of Zero-One Programming Problems*, George Mason Univ. Tech. Rep., 1988.

2. H. CROWDER, E. L. JOHNSON & M. PADBERG, "Solving large-scale zero-one linear programming problems," *Oper. Res.*, v. 31, 1983, pp. 803–834.

28[65–01, 65Fxx].—DARIO BINI, MILVIO CAPOVANI & ORNELLA MENCHI, *Metodi Numerici per l'Algebra Lineare*, Zanichelli, Bologna, 1988, x+514 pp., 24 cm. Price L. 48 000 paperback.

An excellent treatment of numerical methods in linear algebra, this text is destined to become the standard work on the subject in the Italian language. It contains seven chapters, of which the first three are introductory, providing the necessary tools of matrix algebra, eigenvalue theory and estimation, and norms. Chapter 4 discusses the major direct methods, Chapter 5 the more important iterative methods, for solving linear algebraic systems. Methods for computing eigenvalues and eigenvectors of symmetric and nonsymmetric matrices are the subject of Chapter 6. The final chapter deals with least squares problems and related matters.