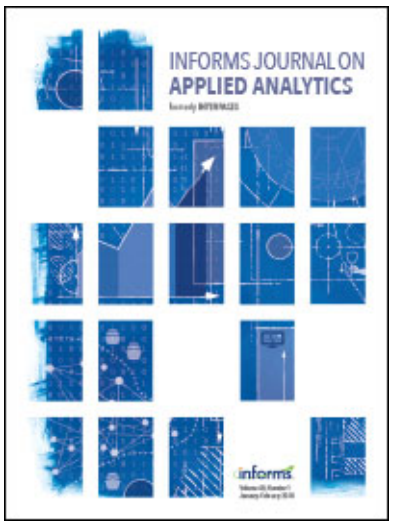

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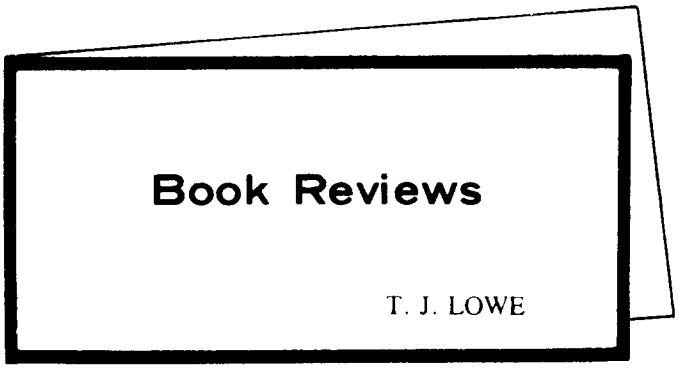

COHEN, JARED L., *Multiobjective Programming and Planning,* Academic Press, 1978, 333 pp.

This book must be considered significant in that it is the first text on multiple objective optimization. Furthermore, it has a unique orientation to public decision-making problems. It is certainly an ambitious attempt to bring together diverse and recent research on such a rapidly developing area and to present it at a level that only assumes high-school algebra. Perhaps this is impossible to achieve; this book certainly falls short of the ideal.

One criticism of the book is its "prose-like" style in which it is difficult to distinguish among theoretical statements (theorems), assumptions, examples, discussions, and proofs. A related, but much more serious, criticism is its imprecise and sometimes incorrect development of key concepts that ultimately depend on a better foundation in mathematical programming. Finally, as is understandable for a book in this rapidly developing area, it suffers from the omission of a number of recent papers.

The core of the book can be conveniently characterized into three parts: an introduction to linear programming (Chapter 3); an introduction to multiple objective programming (Chapters 4, 5, 6, 7, and 8); and a discussion of some case studies (Chapters 9 and 10).

We now turn to the introduction to linear programming given in the first part of the book. A much better foundation could have been established by simply assuming familiarity with an introductory book in mathematical programming and by giving a brief review of the key concepts. This would have avoided difficulties arising, for example, from an inadequate development of sensitivity analysis and parametric programming (pgs. 60–63) and incorrect definitions for a concave function (pg. 168) and a quasiconcave function (pg. 173).

Moving to the second and main part of the book, we consider its development of multiple objective programming.

Four methods in generating efficient points are considered in Chapter 6: the weighting method, the constraint method, the "NISE" method, and the multiobjective simplex method. The most serious drawback of the development is that, for the important bi-objective case, the presentation of the methods is misleading. Specifi-

cally, for bi-objective linear programs, the frontier can be readily generated by using the "continuous" parametric approach via either the constraint or the weighting method. By only considering "discrete" parametric methods, the book just obtains approximations to the frontier. Furthermore, results given in Geoffrion [1967] demonstrate how utilizing preference information only necessitates generating a portion of the frontier. Another troublesome point is the theoretical justification given for the weighting and constraint methods. Both are based rather loosely on the Kuhn-Tucker conditions in that the mathematical justifications are really not established. Worse yet, the assumption of concavity, which is critical for the weighting method, is not even mentioned. It is also unfortunate the recent results [Ecker *et al.* , 1980] on finding efficient faces were not available.

In the next chapter the book considers a number of techniques that incorporate preferences. These include Geoffrion's bi-objective methods [1967], minimum distance methods, goal programming, the surrogate worth trade-off method, the STEP method, and the GDF [Geoffrion, Dyer, and Feinberg, 1972] interactive method. Although it is good to see so many methods presented in one place, the development again is often vague, misleading, or incomplete. This first shows up in the introductory review of utility functions. Here, cardinal utility is assumed without being rigorously defined and the relationship of deterministic cardinality is confounded with the work of von Neumann and Morganstern. In presenting Geoffrion's algorithm 2 [1967] the book overlooks the required concavity assumptions as well as some technical assumptions. It also overlooks the observation that the method can be applied interactively (without a prior utility characterization). The subsection on goal programming is disappointingly brief and undeveloped, especially since the book recognizes that it "is undoubtably the most well-known multi-objective method." Just the most elementary form is presented and pre-emptive goal programming is only mentioned in passing. Omitted is the more general piecewise linear framework and references to the many public decision-making applications (see Charnes and Cooper [1977], including references in [1]). Finally, many of the limitations of goal programming (as noted in Dyer [1977] and Harrald *et al.* [1978] are not discussed. Turning now to the GDF interactive method, the book again fails to state the required convexity/concavity assumptions. Also, it would have been nice to interpret this approach as a method of interactive goal programming [Dyer, 1972].

Given the public decision-making orientation of the book, the next chapter on multiple decision-making methods is especially appropriate. In this chapter a potpourri of methods is discussed. Unfortunately, the relevance of some of them (e.g., two-person zero-sum game theory) is not clear while others, particularly fundamental results from social choice, are not clearly developed (e.g., a specific statement of Arrow's theorem is not given). Also unfortunate is the fact that recent results on applying the spatial theory of voting to the multiple objective problem were not available.

Following the development of multiple objective programming are two chapters containing interesting case studies on river basin planning and locational planning problems, mostly based on the experiences of the author.

In summary, the book may be a good introduction to a broad selection of topics and it certainly has a number of interesting references. Although it has some serious drawbacks as well as a lack of exercises for students, it might be used as a text if properly supplemented by a number of papers.

References

Charnes, A. and Cooper, W.W., 1977, "Goal Programming and Multiple Objective Optimizations: Part I," *European Journal of Operational Research* Vol. 1, pp. 39–54.

Dyer, J., 1972, "Interactive Goal Programming," *Management Science* Vol. 19, pp. 62–70.

Dyer, J., 1977, "On the Relationship Between Goal Programming and Multi-attribute Utility Theory," *International Symposium on Extremal Methods and Systems Analysis,* University of Texas.

Ecker, J. G., Hegner, N. S., and Kouada, I. A., 1980, "Generating All Maximal Efficient Faces for Multiple Objective Linear Programs," *Journal of Optimization Theory and Applications.*

Geoffrion, A. M., 1967, "Solving Bicriterion Mathematical Programs," *Operations Research* Vol. 15, pp. 39–54.

Geoffrion, A. M., Dyer, J. S., and Feinberg, A., 1972, "An Interactive Approach for Multi-Criterion Optimization, with an Application to the Operation of an Academic Department," *Management Science* Vol. 19, pp. 357–368.

Harrald, J., Leotta, J., Wallace, W. A., and Wendell, R. E., 1978, "A Note on the Limitations of Goal Programming as Observed in Resource Allocation for Marine Environmental Protection," *Naval Research Logistics Quarterly* Vol. 25, pp. 733–739.

Wendell, R. E., 1980, "Multiple Objective Mathematical Programming with Respect to Multiple Decision Makers," *Operations Research* (forthcoming).

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KOHN, ROBERT E., *A Linear Programming Model for Air Pollution Control,* The MIT Press, 28 Carleton Street, Cambridge, Mass. 02142, 1978, 250 pp., $20.00.

According to Kohn "... the major emphasis of this book is not on solving the problem of air pollution in St. Louis, but rather on illustrating the usefulness of the linear programming framework for evaluating general impacts of alternative strategies and for relating these strategies to principles of economic efficiency." The book synthesizes the results of several years of studies by Kohn during which 13 linear programming formulations were developed.

The concepts of the linear programming model are presented in Chapter 1. The reader should have some background in linear programming and economics to appreciate this material. The St. Louis data and the linear programming model itself are presented in Chapter 2. The interested reader has sufficient information to set up the model. A clear description of post-optimal analysis and the significance of the dual variables is contained in Chapter 3. The linear programming solution is compared to alternative approaches such as equiproportional abatement. While presented clearly and concisely, this material is standard fare for experienced readers.

In Chapter 4, Kohn describes methods for determining the pollutant transfer coefficients for the model. These transfer coefficients are a vital component in the environmental models. The author presents this information very nicely with sufficient sample calculations to provide a good feel for the numbers and associated units. Chapter 5 applies benefit-cost analysis, within a linear programming framework, to the multiple pollutant control problem. One interesting part of this chapter is a description of the use of environmental index functions. The final chapters extend the standard linear programming formulation to a broader equilibrium analysis framework. The case study results are presented as part of this more theoretical analysis. A brief final appraisal in Chapter 8 includes a discussion of the usefulness of each of the 13 models for airshed planning, simulation modeling, and economic

efficiency analysis.

This book is a valuable contribution for resource economists and environmental engineers. The blending of linear programming, economic theory, and environmental engineering is excellent. The author's experience comes through very nicely throughout the book in his realistic appraisal of the limitations as well as the promise of this approach. Data problems are discussed candidly. Examples and sample calculations enhance the book's value. Kohn's book is a significant step forward in helping make linear programming models relevant to real-work public policy making.

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PUTERMAN, MARTIN, L., ed., *Dynamic Programming and Its Applications*, Academic Press, 1978, 410 pp.

Because of the versatility and appeal of dynamic programming, both theoretical and applied, papers dealing with it are usually dispersed in several journals of various professions. This fact tends to limit the transparency of dynamic programming, particularly among Operations Researchers and Management Scientists. This book is the most recent single collection of some of the important developments in the field; it spans the gamut of theories and applications of dynamic programming, including works of a number of the major researchers in the field. Very importantly, it is put together most meticulously by Professor Puterman.

The contents of this book, with the exceptions of the contributions by Lembersky and White, constitute the Proceedings of the International Conference on Dynamic Programming and Its Applications held in April 1977 at the University of British Columbia, Vancouver, Canada. Puterman indicates that he had reviewed all of the papers and in most cases sought external referees. This then may explain why it is considerably different from most proceedings, especially in the quality of the contents of the book. With the exception of a few historical inaccuracies and the terseness of some of the presentations, the quality of the material is exceptional. Only very few typos were discerned in this 400+ page manuscript — a remarkable feat indeed considering the numerous equations and symbols it contains.

The book, divided into three groupings, survey, applications, and theory, includes an edited version of a panel discussion dealing with the state of the art and future directions of dynamic programming by Hinderer, Denardo, and Veinott. The correctness of this grouping is understandably subject to debate. Every subject appears to fit the general theme of the book with the exception of the paper by Denardo and Fox, "Buckets, Shortest Paths, and Integer Programming," which although excellent and interesting, belongs elsewhere.

The survey section contains excellent synopses of works in Markov decision processes including analytical theories and novel computational strategies, dynamic programming in Borel Spaces, and a chronicle of computational advances in dynamic programming by Morin.

The section on applications includes an application of Strauch's discrete time parameter negative dynamic programming to a class of renewal decision problems by Derman, Lieberman, and Ross; development and application of efficient DP heuris-

tics to optimal economic growth in dynamic economic planning problems by Flynn; an application of Markov decision processes to long-term forest management problems by Lembersky; a statistical application involving the use of backward induction technique of DP in the modeling and analysis of medical trials by Petkau; and finally, various applications involving simple feedback and adaptive control models in fisheries management by Walters.

The theory section includes Doshi's discussion of both the modeling and theoretical studies of diffusion processes with reflecting boundaries and both continuous and lump costs. This paper could have quite conceptually been included in the applications section. An instructive paper on approximate solutions of finite stage dynamic programs is given by Hinderer. Denardo and Rothblum give a précis of their work on affine dynamic programming; Iwamoto discusses inverse dynamic programming, particularly the infinite stage case; while Pliska presents results on the transient case for discrete time DP allowing general state and action spaces. Schal builds on Strauch's negative dynamic programming and generalizes the works of other workers in this field. Finally, Wijngaard considers the existence of average optimal strategies in Markovian decision problems with strictly unbounded costs.

As excellent as this manuscript is, it does not and cannot replace any existing DP text. However, it is recommended as a useful reference work and perhaps as a book of readings in an advanced graduate course on dynamic programming, in which case the section on applications would need to be appropriately supplemented.

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