Operations Research

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

The Analyst's Bookshelf

To cite this article:
(1966) The Analyst's Bookshelf. Operations Research 14(6):1155-1157. https://doi.org/10.1287/opre.14.6.1155

The Analyst's Bookshelf

Reviews

SANFORD M. ROBERTS, *Dynamic Programming in Chemical Engineering and Process Control*, Academic Press, New York, N.Y., 1964, 471 pages, $14.50

STUDIES of a purely mathematical character have brought to light many consequences of Bellman's celebrated 'Principle of Optimality.' Valuable efforts have also been made to apply this theory to a variety of practical problems. The aim of this book is to initiate chemical and process engineers to the actual use of dynamic programming, and to give them a fair idea of the successes (and failures) people have experienced in this challenging field.

The first chapter consists of a brief introduction to the subject, i.e., what a multistage decision process is and how dynamic programming will generate the optimal policy.

The replacement problem, treated in Chapter 2, is a simple one, and is well suited to introduce the reader to an important technique: the derivation of the functional equations relevant to the problem at hand. The computational aspect of the actual solution is appropriately stressed, and the use of the tables generated by the computer is discussed thoroughly.

Allocation problems (Chapter 3) are a little more difficult to handle, and, although much of the material is very lucidly covered, the author has not avoided a rather subtle pitfall; feedback optimization problems can sometimes be handled by extensions of dynamic programming, but the method[1] described in Chapter 3, §10, is in general incorrect.[2] This question has given rise to some controversy and the cautious reader would be wise to consult references 3 and 4 before embarking on the solution of an actual feedback problem by dynamic programming.

As the author repeatedly claims the superiority of dynamic programming over the calculus of variations, Chapter 4 gives some support for this view. Although it is possible to derive the conditions of the calculus of variations by dynamic programming, this fact does not imply that the latter is the most powerful method. Actual comparisons of computer time point sometimes heavily in favor of Pontryagin's maximum principle.

At any rate, in the reviewer's opinion every user will rate as the best optimization technique the one he is most familiar with, so that every comparison is bound to reflect certain subjective elements.

The author is at his best while describing the computational aspects of dynamic programming (Chapter 5). Since this approach requires the use of high-speed computers, it is important to know by what purely numerical procedure the solution is generated. This has been logically done here, for one-dimensional problems, by describing the grid of states at whose nodes the optimum return is to be calculated. The table obtained in this way yields not only the optimal policy, but also the 2nd best, 3rd best, and kth best policies.

Consideration of these alternative—near optimal—policies is in point when the implementation of the optimal policy calls for an impractical set of decisions.

The difficulties associated with multidimensional problems are clearly emphasized. Among other topics, the author discusses the attractive technique of reducing dimensionality by linearization (or quasilinearization), and he presents various approximation methods.

As there is a straightforward analogy between the concepts of feedback control and multistage decision processes, the methods of dynamic programming have been applied to the design of optimal nonlinear control systems. Chapter 6 describes various deterministic control problems in general terms: averaging control, terminal control, minimum-of-maximum-deviation control, and control of systems with time-lag. The difficulties arising in the solution of this last problem are duly stressed.

Three chemical engineering control problems (Chapter 7) are then carefully examined in the light of the general theory previously developed. The physical systems under study are tanks whose levels are to be maintained within certain limits, a tubular reactor, and a countercurrent absorber with a linear equilibrium relation (with quadratic performance index).

The book is rounded-off with introductions to inventory problems and stochastic processes. These are still areas of active research, since even the dynamic programming approach gives an easily workable solution only under favorable conditions.

It would be a mistake to read this book without paying some attention to the wealth of problems collected after each chapter, even if one does not want to carry out the solutions in detail; they are extremely well presented, and give a good idea of the range of successful applications of dynamic programming.

REFERENCES

1. J. S. Dranoff, L. G. Mitten, W. F. Stevens, and L. A. Wanninger, Jr., "Application of Dynamic Programming to Countercurrent Flow Processes," *Opns. Res.* **9,** 388–401 (1961).
2. ———, ———, and ———, "Letter to the Editor," *Opns. Res.* **10,** 410–411 (1962).
3. D. Yesberg and R. Aris, "Dynamic Programming in Countercurrent Systems," *J. Math. Anal. Appl.* **7,** 421–424 (1963).
4. R. Aris, G. L. Nemhauser, and D. J. Wilde, "Optimization of Multistage Cycle and Branching Systems by Serial Procedures," *A. I. Ch. E. Journal* **10,** 913–919 (1964).

S. J. Wajc
Université Libre de Bruxelles

GEORGE B. DANTZIG, *Applications et Prolongements de la Programmation Linéaire*, Dunod, Paris, France, 1966, 446 pages, 88 francs

THIS BOOK, which was translated and 'adapted' by E. Ventura from the author's *Linear Programming and Extensions*, Princeton University Press, second printing, 1965 [reviewed by John W. Abrams in this journal, **14,** 734–737

(1966)], is no ordinary translation. The reader would be well advised to read the preface thoroughly since it clearly and succinctly describes the purpose of the book, namely, to present in the French language the unique and significant message of the English text, and, in so doing, to preserve the approach and method of thought of the author. With this rationale, the material on graph theory has been virtually eliminated because of its availability in French, and two other significant abridgements have also been made: the two initial chapters of the original text have been omitted, as well as the introduction to the classical transportation problem. Other deletions from the original include the detailed treatment of Stigler's nutrition model, the discussion of the four-color map problem, certain of the exercises, and all of the problems. This latter may, regretfully, restrict the value of the book to students—it may even operate against the rationale; Dantzig's choice of problems is not an insignificant manifestation of his approach.

Subject to these restrictions and the fact that the omission of discussion of the classical transportation problem may render the subsequent treatment of weighted and capacitated problems more difficult, the translator-editor has done a magnificent piece of work. The translation is superb, retaining the spirit of the original, remaining very close to the English text, and attaining these goals with a minimum of awkward phraseology. There are passages which actually flow more naturally in the translation than in the original, but this may be partially due to an improved format: In the original version many mathematical expressions are contained within the text; in the translation, they are broken out and shown separately. The gain in ease of reading is remarkable.

M. Ventura has accomplished his objective in an outstanding manner. He has made available to the French-speaking world without distortion the veritable gold mine of ideas presented by Dantzig. English-speaking, bilingual readers may also read it with profit.

John W. Abrams
University of Toronto

Books Received

Associazione Italiana di Ricerca Operativa, *Quaderni RO, Numero Quattro*, Editore Boringhieri, via Brofferio 3, Torino, Italy, 1965, 153 pages, 2000 lire (paper). Thirteen papers given at the Fourth Scientific Meeting of the Italian Operations Research Association, held at Pisa, 29–31 October 1964.

N. R. Draper and H. Smith, *Applied Regression Analysis*, John Wiley and Sons, New York, N.Y., 1966, 417 pages, $11.75.

J. Ferrier, *La Gestion Scientifique des Stocks*, Dunod, Paris, France, 1966, 352 pages, 34 francs (paper).

Bertil Hållsten, *Investment and Financing Decisions: On Goal Formulation and Model Building*, The Economic Research Institute, Stockholm School of Economics, Stockholm, Sweden, 1966, 149 pages, 36 Swedish kroner (paper). A doctoral dissertation.

Werner Z. Hirsch (editor), *Regional Accounts for Policy Decisions*, The Johns Hopkins Press, Baltimore, Maryland, 1966, 244 pages, $6.50. Six papers with

comments presented at the 1964 Conference on Regional Accounts; there is an introduction by the editor.

ALLEN KENT, *Textbook on Mechanized Information Retrieval, Second Edition*, Interscience Publishers, New York, N.Y., 1966, 391 pages, $10.95.

HELMUT KRAUCH, WERNER KUNZ, AND HORST RITTEL (editors), *Forschungsplanung: Eine Studie Über Ziele und Strukturen Amerikanischer Forschungsinstitute*, R. Oldenbourg Verlag, Munich, W. Germany, 1966, 283 pages, DM 38.

THOMAS H. NAYLOR, JOSEPH L. BALINTFY, DONALD S. BURDICK, AND KONG CHU, *Computer Simulation Techniques*, John Wiley & Sons, New York, N.Y., 1966, 368 pages, $9.50.

DOUGLAS F. PARKHILL, *The Challenge of the Computer Utility*, Addison-Wesley Publishing Co., Reading, Mass., 1966, 219 pages, $7.95.

DANIEL ROOS, *ICES System Design*, The M.I.T. Press, Cambridge, Mass., 1966, 372 pages, $5.00 (paper). A doctoral dissertation describing the Integrated Civil Engineering System at MIT, a computer aid to the solution of civil engineering problems.

MICHEL SIMONNARD, *Linear Programming*, Prentice-Hall, Englewood Cliffs, N.J., 1966, 454 pages, $12.00. A translation by WILLIAM S. JEWELL of a book originally published in French by Dunod, 1962; the translation includes some substantial revisions worked out by the author after the publication of his original edition. The translator has appended an English-French glossary of technical terms.

PETER STAHLKNECHT, *Operations Research: Ein Leitfaden für den Praktiker, Teil 2, Simulationsmethoden/Ablauf- und Terminplanung*, Friedr. Vieweg & Sohn, Braunschweig, Germany, 1966, 64 pages, DM 12 (paper).

J. S. WENTZEL, *Elemente der dynamischen Programmierung*, R. Oldenbourg Verlag, Munich, W. Germany, 1966, 131 pages, DM 28. A translation by R. HERSCHEL of a book originally published in Russian in 1964.

NORBERT WIENER, *Nonlinear Problems in Random Theory*, The M.I.T. Press, Cambridge, Mass., 1958, 141 pages, $2.45 (paper). A reprint.

M. C. YOVITS, D. M. GILFORD, R. H. WILCOX, E. STAVELY, AND H. D. LERNER (editors), *Research Program Effectiveness*, Gordon and Breach, Science Publishers, Inc., New York, N.Y., 1966, 560 pages, $10.00. A collection of 24 papers given at a conference sponsored by the Office of Naval Research and held in Washington, D. C., July 27–29, 1965.

Notes

Mathematical Biosciences: An International Journal, a new quarterly journal, will begin publication in 1967 under the editorship of RICHARD E. BELLMAN, Department of Electrical Engineering, School of Engineering, University of Southern California, University Park, Los Angeles, California 90007. The Associate Editors are W. ROSS ADEY, KENNETH M. COLBY, H. E. DERKSEN, R. W. GERARD, V. GLUSHKOV, FRED S. GRODINS, JOHN A. JACQUEZ, SAMUEL KARLIN, A. KATCHALSKY, TOSIO KITAGAWA, D. KENDALL, R. LATTES, G. MALECOT, J. NEYMAN, GORDON