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Reviews

G. HADLEY, *Nonlinear and Dynamic Programming*, Addison-Wesley Publishing Company, Reading, Massachusetts, 1964, 484 pages, $10.75

THIS text if the third member of a trilogy, the first two of which are *Linear Algebra* and *Linear Programming* (Addison-Wesley Publishing Company, 1961 and 1962 respectively; for a review by John W. Abrams of the second of these two books, see this JOURNAL, **14** (1966), pages 734–737). In general character and point of view, this volume is similar to the two earlier works, and, indeed, assumes a rather thorough familiarity with them.

Chapter 1 is a brief introduction to, and survey of, general constrained optimization problems, including a good informal presentation, through examples, of the difficulties created by nonlinearities. Chapter 2 is an extremely compact review of linear algebra, linear programming, and n-variable differential calculus, especially the implicit function theorem. Continuing the introductory material, Chapter 3 is concerned with classical optimization methods and the relevant properties of convex and concave functions. The principal subject here, of course, is the use of Lagrange multipliers for both equality and inequality constraints. This chapter also uses Lagrange multipliers to introduce complementary slackness and duality in nonlinear programming.

Chapter 4 contains an extensive discussion of approximate linearization methods for separable programs. A major feature in this chapter is the use of the simplex method with restricted-basis entry to satisfy automatically the special nonlinear constraints that arise in this approach. Chapter 5, "Stochastic Programming," is concerned almost entirely with some of the ways in which stochastic programs can arise in practice and with the general types of difficulties created by the presence of random elements. Chapter 6 presents a moderately general version of the Kuhn-Tucker conditions, with proofs, and Chapter 7 is a survey of the methods published prior to 1964 for solving quadratic programs. The first half of Chapter 8 describes the many ways in which integer linear programming problems can arise, including both natural applications and also mathematical transformations of originally non-integer problems such as the linear approximations to separable problems; the second half gives Gomory's algorithms for both the all-integer and mixed-integer cases. Chapter 9 describes a variety of gradient methods.

The final two chapters, "Dynamic Programming I" and "Dynamic Programming II," represent an appreciable shift in content, although not in general approach. Chapter 10 is primarily concerned with dynamic programs involving one state variable, including infinite-stage and stochastic problems, while problems requiring more than one state variable are treated in the first third of Chapter 11. The final two-thirds of this last chapter discusses two specific applications in some detail: combined production-scheduling and inventory-control problems, and dynamic programming in a Markov process.

The general orientation of the book is toward the practitioner rather than the mathematician, although the emphasis is only somewhat more computational than theoretical. This is 'computational' in the best sense of the word, however, in that the concern is neither with computer codes nor the mechanical application of apparently arbitrary computing rules, but rather with the general computational efficacy of proposed algorithms. In particular, this concern tends to lead, wherever possible, to an emphasis on simplex and simplex-like methods for nonlinear programs. Indeed, many of the numerical examples yield series of linear programming tableaux, and a number of formal results are obtained by using the mathematical properties of the simplex (and related) algorithms. Another reflection of the concern for the practitioner is the high degree to which motivation is supplied by more or less realistic applications, even to the extent of having one chapter (that on stochastic programming) consist primarily of such motivation.

Although the main emphasis is on computation and application, the book is far from trivial mathematically. All important results are proved, but not always rigorously. In some cases, notably the classical use of Lagrange multipliers and the Kuhn-Tucker conditions, the results are presented with surprising and pleasing generality. The contents of the review chapter (Chapter 2) reveal that the required mathematical background is substantial, and the rest of the book shows that the required mathematical maturity is also appreciable.

Two aspects of the mathematical characteristics of the book are somewhat disturbing, however. One is that the review chapter, like many such reviews, is like the proverbial leaky umbrella: If one needs it, it is of little use, while if one does not need it, it is superfluous. The second criticism is that in many cases formal results are obtained too mechanically with too little interpretation of, or motivation for, the mathematical content (as noted above, this is not true of either the computational or application content). Two reflections of this are the sometimes needlessly formal notation and the frequent inclusion of routine manipulations without an accompanying discussion of what is really being done mathematically and why.

The most disappointing feature of this work is its lack of unity and cohesiveness —the last nine chapters can very nearly be studied in any order, each being almost independent of the others—a fact that in large part is a consequence of the subject. It is clearly recognized by the author in the Preface, where some justification is given on the grounds that "... there does not exist at present any unifying theory for all of what might be considered nonlinear programming and ... in addition, computational algorithms exist only for solving very special types of problems ..." While this is certainly at least nearly as true today as in 1964, yet even then there were available more unified descriptions of at least part of the subject matter of this book: PHILIP WOLFE, "Some Simplex-Like Nonlinear Programming Procedures," *Operations Research*, **10,** 438 (1962); or the same author's "Computational Techniques for Nonlinear Programs," Princeton University Conference on Linear Programming, March 13–15, 1957 (!).

One distinguishing feature of an outstanding text is the extent to which it brings unity to a previously fragmentary field. Unfortunately, this book succeeds only to a limited extent in this respect, but perhaps somewhat unintentionally. Some unification is achieved through the early general treatment of Lagrange multi-

pliers, the repeated use of simplex-type procedures, and, to a lesser degree, applying the Kuhn-Tucker conditions in several contexts. These possible unifying threads, however, are not followed consistently, each being more a leit-motif than a dominant theme. Although the unity of subject leaves something to be desired, the consistent unity of style and of point of view, however, is a partial compensation.

This book is intended primarily as a text, and for the right combination of lecturer and class it will serve that purpose excellently. The 'right class' would be at the first-year graduate level in a mathematically oriented operations-research program, the mathematical prerequisites probably being excessive for many business schools; the 'right lecturer' would be one who could (hopefully) provide some of the missing unity, who could select intelligently from the large number (almost 400) of exercises, some of which are trivial and/or mechanical and some of which are very good indeed, and who could include coherently more recent results (especially in stochastic and quadratic programming, and in integer programming if included in the course). A possible selection and sequence of topics might be Chapters 3, 6, 7, 5, 4, and 9, assuming that integer linear programming and dynamic programming would be more appropriately studied elsewhere.

Writing the first text in a field as diverse as nonlinear programming is an audacious undertaking and leaves the author open to criticisms of the sort that would be made of texts in fields already adequately covered. While I have taken advantage of this license, my remarks should not obscure the fact that HADLEY's book is indeed the first general text in this area. The principal observation should be not that it is not perfect, but, rather, that it succeeds as well as it does.

WILLIAM W. HARDGRAVE
Bell Telephone Laboratories, Inc.

ITHIEL DE SOLA POOL, ROBERT P. ABELSON, and SAMUEL L. POPKIN, *Candidates, Issues, and Strategies: A Computer Simulation of the 1960 Presidential Election*, The MIT Press, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1964, 167 pages, $5.95

THIS BOOK presents an application of a new social science technique: a marriage of computer capabilities, public-opinion-survey data, and opinion-formation theories. The project that developed this technique designed a simulation that used opinion-poll statistics to examine campaign strategies and predict their effects on the election. To use computer simulations in examining voter behavior is not new—as the authors point out, WILLIAM MCPHEE produced a model in 1959 that traced political waves in a four-year election cycle. However, this project has contributed an initial step in developing and utilizing computer simulation models to answer questions that a candidate may ask during a campaign; to this end, the model must produce predictions based on existing historical data while there is still sufficient time for the candidate to effect a change in his strategy or tactics.

As the project conceived it, the model "would focus on items about which (*a*) a candidate has genuine strategic alternatives, (*b*) the behavioral sciences have some relevant theories, [and] (*c*) the necessary data exists."

Since campaign issues satisfy these requirements, this is the topic around which the simulation was developed. In recent years public-opinion-poll archives have

appeared as centralized storage areas for poll data, and the behavioral sciences have developed theories of balance and cross pressure that are relevant to formulating campaign strategies.

Chapter I presents the background of the project: its conception, organization, and the behavioral theories on which the simulation was based. A definition of simulation is offered, and there is a discussion of its purpose and proper application.

The project reduced data from 50 national surveys to provide information on 52 'issue-clusters' for 480 voter types. Since the use of a number of different surveys posed problems of compatibility, scope, and intensity, the approach to these problems is discussed briefly. The vast effort the project devoted to preparing the data can readily be appreciated.

The voters were divided by socio-economic factors. Each of the 48 states was assumed to differ from other states in its region only because of the differences in the proportions of the regional voter types in that state, an assumption that is admittedly questionable; its justification, in the authors' opinion, lies in the quality of the state-by-state predictions made by the simulation model. The importance of local political leaders' stands in the South, for example, yielded poor correlations with the actual state-by-state outcomes.

To examine a scenario in which the religious issue was dominant, the project chose formulas to represent the responses of the 480 voter types to the candidates in the light of past voting inclinations and attitudes toward a "Catholic in the White House." These formulas were developed from survey information, behavioral theories, and subjective judgment.

Chapter II deals with the sensitivities of the predictions to the values of the variables in the simulation. Thus, it examines foreign policy disputes, the effects of different values of the Catholic shift on the goodness of fit of the simulation, and the Civil Rights issue (this after-the-fact inquiry found that this issue did not cause significant cross pressure outside small groups of voters).

Chapter III discusses various simulations, including the "best-fit simulation" for the 1960 Presidential campaign from the viewpoint of post-diction. Since the purpose of this latter examination was to enhance the understanding of voter behavior in that election, state-by-state correlation and root mean square error were used as standards of goodness of fit. The root mean square of the differences between the Kennedy percentage in the best-fit simulation and the election was 4.7% over 48 states. Here, both parameters and factors of the 1960 simulation were varied or deleted, a special shift was used in the southern states to account for Negroes who would otherwise have voted Republican and whites who would have voted Democratic, and the data deck was augmented by polls taken between the biennial elections of 1958 and 1960.

This chapter also offers some conclusions from the 1960 campaign—for example, the best-fit simulation indicated a loss in popular vote, but a gain of 22 electoral votes for the late President Kennedy, due to the religious issue. It goes on to discuss civil rights, foreign policies, and other issues, and the special southern vote adjustment needed to improve state-by-state predictions.

Chapter IV considers the question of the summability of predispositional factors, a topic relevant to behavioral-science theories of voter-opinion formation. To

examine the factors of political party, region, sex, religion, and socio-economic status, the project used analysis-of-variance techniques with a five-way factorial array of 336 of the 480 voter types. After F-testing the factors and the ten first-order interactions within a cluster, and after investigating the distribution of F's for the first-order interactions, the authors answer the question of summability with a qualified "yes." "However, for party-dominated issues, party identification quite often interacts with other factors; that is, party identification does not always summate with other factors in determining issue response."

The final chapter outlines the political trends of the 1950's in the light of public-opinion-poll-data and election results, and discusses the effects of Eisenhower and Stevenson on the normal responses of voters.

Since timely predictions would be of considerable assistance to a candidate and his staff of advisors, this book presents an interesting and potentially important application of simulation and computer capabilities. Too, since the aim is to go beyond the opinion polls to predict voter responses before they have made up their minds in the actual campaign and to do this using old poll data, the simulation may increase the usefulness of the opinion polls. While much of the simulation analysis in this first application was done after the fact, it nevertheless provides insight to voter behavior in the 1960 election. If the proper campaign scenario can be chosen, the simulation using historical data provides a good prediction of voter responses. To select the proper scenario may not always be as easy as it was in the 1960 election campaign, but, on the other hand, the simulation may not be particularly useful in campaigns that are straightforward (the Democratic side of the 1964 campaign may be taken as an example).

To be attractive to the political parties, simulations must provide better or more timely predictions than the alternative techniques when crucial strategy decisions must be made, capabilities that are at least conceptually in view at the present time. However, it remains to be seen whether or not simulation techniques will become standard decision aids for political campaigns. In any case, the operations analyst will find this book to be of interest as an example of the application of his techniques to important problems of social behavior.

WILLIAM M. TAYLOR
Caywood-Schiller, Associates

IRA HOROWITZ, *An Introduction to Quantitative Business Analysis*, McGraw-Hill Book Company, New York, 1965, 282 pages, $7.95

THIS BOOK, based upon a course taught at Indiana University, is directed to those who have a limited mathematical background, requiring no more of its readers than course work in college algebra and elementary statistics. The author does, however, attempt to show the why of the techniques he discusses as well as the how. Thus, both the level of mathematical sophistication expected of readers and the number of topics that can be reasonably covered in a one-semester course have served to limit both the breadth and the depth of the coverage of the book.

The material treated includes linear programming, the transportation method, integer programming, game theory, queuing theory, inventory models, and Bayesian

decision-making. It is the last topic which receives primary attention, with rather well written chapters on "Utility in Decision-Making," "The Value of Additional Information," and "Decisions Under Uncertainty." Among the notions the reader is exposed to are the principle of insufficient reason, the Hurwitz criterion, minmax regret, and mixed strategies. Further, in the chapter titled "Linear Programming," a section is devoted to using programming to develop data for decision-making under risk.

The quality of the presentation shows some variation. On the one hand, the chapter on "Probability and Expected Value" is very disappointing. The student meets, in the following order, sections entitled "Expected Value," "The Concept of Personal Probability," "The Rules of Probability," "The Variance," and "Some Frequently Used Probability Distributions." Since the background of those to whom the book is directed will generally not include a firm grounding in probability, the rather cursory treatment of these subjects seems unwise. Though a treatise on this topic is not called for, a more extensive, more rigorous treatment of the material contained in this chapter would certainly facilitate the novice's understanding of the content of the chapters which follow.

On the other hand, the chapter on linear programming neatly develops the basic concepts and the simplex algorithm by means of discussion, numerical examples, and algebraic manipulations. However, midway through this chapter matrix notation is introduced with three terse lines, an abbreviated presentation that unfortunately leaves the student with the erroneous notion that "the product of two columns of numbers" is always a scalar. Since the author does not make any explicit statements regarding the properties of matrices, a modest appendix on matrix algebra would seem to be desirable.

One finds in the following chapter a rather good introductory treatment of integer programming. A chapter is also devoted to the transportation problem; in it the author takes the time to indicate, algebraically, its relation to the general linear programming problem.

The treatment of inventory problems contains the traditional models, with a digression on calculus, plus a discussion of the *ex post* calculation of holding cost and the simulation (though simulation, per se, is not discussed) of the effects of an inventory policy when shortage costs are unknown. The author further demonstrates the application of the inventory concepts in his chapter on queuing models. The treatment of queuing, which includes the elementary single-server models and the bounded single-server model, is, as a whole, lucidly presented. However, the author unnecessarily violates his objective of making the whys understandable to the novice when he introduces homogeneous difference equations into a derivation that could have been handled by induction.

In the chapter on competitive models, two-person zero-sum games (and their relation to linear programming), and two-person nonzero-sum games are clearly presented. The reader is introduced to the bargaining situation and led to the NASH point solution (though Nash is not acknowledged).

The author's informal conversational style of presentation makes this a very readable text, and the examples are generally clear and easy to follow. However, a revised edition would be considerably strengthened by including several ap-

pendices containing both the 'digressions' the author feels are inappropriate in the main body of the text and slightly more advanced material for the more highly motivated reader. Evaluating the book against the author's objectives, one finds he has met the goal of providing for the mathematically unsophisticated a reasonably integrated introductory presentation of the Bayesian and traditional approaches to decision making.

EUGENE E. KACZKA
University of Massachusetts

Books Received

MARCUS ALEXIS AND CHARLES Z. WILSON, *Organizational Decision Making*, Prentice-Hall, Englewood Cliffs, N.J., 1967, 461 pages, $10.00. A text with readings.

EDWARD H. BOWMAN AND ROBERT B. FETTER, *Analysis for Production and Operations Management*, Third Edition, Richard D. Irwin, Inc., Homewood, Illinois, 1967, 886 pages, $12.65. A combined revision of *Analysis for Production Management*, 1957 and 1961 [reviewed in this JOURNAL by JOHN E. GESSFORD, **5,** 604 (1957), and *Analyses of Industrial Operations*, 1959 [reviewed in this JOURNAL by J. F. McCloskey, **9,** 283 (1961)].

HAROLD BRAYMAN, *Corporate Management in a World of Politics: The Public, Political, and Governmental Problems of Business*, McGraw-Hill Book Co., New York, N.Y., 1967, 284 pages, $7.95.

DIMITRIS N. CHOROFAS, *Control Systems Functions and Programming Approaches, Volume B: Applications*, Academic Press, New York, N.Y., 1966, 300 pages, $11.00.

GEORGES CULLMAN AND MAURICE DENIS-PAPIN, *Exercises de Calcul Informationnel avec leurs Solutions*, Editions Eyrolles, 61 Boulevard Saint Germain, Paris, France, 1966, 221 pages, 42.26 francs (paper).

ALVIN W. DRAKE, *Fundamentals of Applied Probability Theory*, McGraw-Hill Book Co., New York, N.Y., 1967, 299 pages, $9.75.

PETER F. DRUCKER, *The Effective Executive*, Harper & Row, New York, N.Y., 1967, 188 pages, $4.95.

STEPHEN MICHAEL ELONKA AND ORVILLE HOWARD JOHNSON, *Standard Industrial Hydraulics Questions and Answers*, McGraw-Hill Book Co., New York, 1967, 318 pages, $10.95.

STEPHEN ENKE (editor), *Defense Management*, Prentice-Hall, Englewood Cliffs, N.J., 1967, 404 pages, $12.95. A collection of 20 essays on Pentagon decision making, cost-effectiveness applications, and special defense problems, by 24 authors: ARMEN A. ALCHIAN, MARTIN J. BAILEY, NORMAN V. BRECKNER, HARRISON S. CAMPBELL, HARRY J. GILMAN, T. K. GLENNAN, JR., ROBERT N. GROSSE, HERMAN KAHN, A. W. MARSHALL, JOHN J. MCCALL, ROLAND N. MCKEAN, R. H. MCMAHAN, JR., JORA R. MINASIAN, FREDERICK T. MOORE, WILLIAM A. NISKANEN, JOSEPH W. NOAH, ROLF PIEKARZ, ARNOLD PROSCHAN, RICHARD B. RAINEY, JR., JAMES R. SCHLESINGER, D. H. TAYLOR, MURRAY L. WEIDENBAUM, ANTHONY J. WIENER, AND CHARLES WOLF, JR.

KURT HAIN, *Applied Kinematics*, Second Edition, McGraw-Hill Book Co., New