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Reviews

G. P. PATIL (editor), *Random Counts in Scientific Work:* Volume 1—*Random Counts in Models and Structures*, Volume 2—*Biomedical and Social Sciences*, Volume 3—*Physical Sciences, Geosciences and Business*, Pennsylvania State University Press, University Park, Pa., 1970, 268, 267, and 232 pages, $9.50 per volume

THESE THREE volumes constitute an expanded proceedings of a symposium sponsored by the Biometrics Society and the AAAS. There is a standard review available for all such meeting proceedings, to wit: there are some very good papers included, some very bad ones, some on which no comment by any reviewer seems applicable, and some for which this particular reviewer cannot knowledgeably pass judgment.

The contents of these volumes include theory and applications of discrete distributions to biological, physical, and business data. After reading these proceedings an investigator will still find the problem of fitting his discrete data to a distribution to involve greater elements of art than science, but the field is relatively new and one hopes that a basic set of procedures will jell. Of particular interest are papers by GART, SPROTT, FIENBERG AND HOLLAND, LORD, and CHATFIELD. All of these have the common feature that the author has dealt with real data and has words of wisdom for those who wish to do likewise. Gart's paper is on graphical procedures for discrete data, and has the virtue of recommending simple procedures that allow the investigator to 'feel' his data before entrusting it to an impersonal computer program. I would be tempted to say that scientific progress comes mainly from simple procedures that allow an investigator to stay close to his data at all stages of analysis. Sprott's paper discusses exact methods of inference applied to several common discrete distributions. Fienberg and Holland discuss the elimination of zero counts in contingency tables. Although this is an interesting contribution, it is not on the main subject of the symposium and might more reasonably have been published as a journal article. Lord's paper presents an interesting and specific treatment of the analysis of test score data with much wider application to heterogeneous populations. Chatfield's paper is devoted to applications of discrete distributions to advertising data.

Two of the papers, by FROGATT and KEMP, illustrate an all too common sequence of events in the biological sciences. A reasonably simple theory (or distribution) is found to fit a fairly large set of data. Some further data is then found for which it is hoped that closer data analysis will suggest underlying mechanisms. All too often one finds a fairly wide choice of fundamental events that lead to models that fit the data, so that data analysis alone will not help to choose between them. The competent researcher then abandons purely statistical methods, but his weaker brother continues to confuse common or garden curve fitting with scientific endeavor. The two papers in question are on medical epidemiology, and on accident proneness. It may fairly be said that, although there have been interesting practical conclusions from simple theories in the past, the more recent research seems to lead to more questions of a theoretical nature, and to fewer conclusions that find practical application.

These volumes have enough articles of interest in them to be in a statistical library, but not enough for private purchase except for researchers specifically in the field of discrete distributions.

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E. POLAK, *Computational Methods in Optimization, A Unified Approach*, Academic Press, New York, 1971, 329 pages, $17.50

THIS MONOGRAPH is written in the breathless and telegrammatic style so popular in modern mathematical exposition. As a result, an enormous amount of information on optimization is to be found in a finite space, but in a form that seems, to the reviewer, very difficult to use. Very little in the way of motivation is provided to the reader, and far too few words of caution or other indications of the practical limitations of the methods described are given.

The author's format consists of setting out algorithms in a fairly clear style relentlessly followed by armies of theorems, corollaries, lemmas, and exercises. Consequently, the book can be recommended to those with optimization problems who have some preliminary notion of the field, and preferably have some experience. It does not appear to me to be suitable for learning or teaching the subject, because so much interpolation is required.

The subject matter is at a rather advanced level, since the readers' acquaintance with linear and dynamic programming is assumed. The topics include unconstrained minimization, the effects of equality and inequality constraints, convex optimal control, and convergence rates. There is no discussion of integer programming, or otherwise discrete problems. One notes with disappointment the very small amount of illustrative numerical examples.

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G. F. NEWELL, *Applications of Queueing Theory*, Chapman and Hall, London, 1971, 148 pages, $8.75

CONTRARY to what the title might suggest, this book does not contain any case studies of queuing phenomena, with details of the problems that arose and indications of how and to what extent queuing theory was used to solve them. Rather, like most of the current literature on the subject, it is concerned with the "mathematical analysis of hypothetical problems." The author feels that as a tool for solving practical problems the existing theory of queues is still in a "primitive state," having grown from "solutions looking for a problem," rather than vice versa. His objective is to "turn queuing theory around and point it toward the real world," and for this purpose he has presented in this book his own particular brand of the theory.

In chapter 1 a typical class of queuing situations is considered. Suppose that $t_j (j=1, 2, \cdots)$ are the arrival times of customers into a queuing system, $t_j' (j=1, 2, \cdots)$ the times when customers commence their service, and $t_j'' (j=1, 2, \cdots)$ the times when they complete their service. A mathematical description of the system consists of a set of rules whereby the times t_j' and t_j'' can be evaluated from given values of the t_j. Let $A(t)$ be the number of t_j with $t_j \leqq t$, and $D(t)$ the number of t_j' with $t_j' \leqq t$. Then the queue length at time t is given by $Q(t)=A(t)-D(t)$,

assuming that initially the system was empty. For a graphical representation of the evolution of the system it is suggested that the functions $A(t)$ and $D(t)$ be plotted on the same graph. Then (i) $Q(t)$ is the vertical distance at t between the two curves $A(t)$ and $D(t)$, regardless of the queue discipline or the number of servers, and (ii) if the queue discipline is first-in, first-out, then the queuing time of the jth customer is the area of a horizontal strip between $A(t)$ and $D(t)$ between heights $j-1$ and j. The average queue length and the average queuing time can also be obtained from this graph. This approach is again used in chapter 3 to describe queues in parallel and in series, queues with several types of customers and work-conserving queues.

Chapter 2 treats fluid approximations where the arrival function $A(t)$ and the departure function $D(t)$ are both approximated by nonrandom continuous functions. Specifically, assume that the instantaneous arrival rate at time t is given by $A'(t) = \lambda(t)$, and the service rate $D'(t)$ is either constant or piecewise constant. For example, if the service rate is μ in an interval (t_0, t_3) then the queue length at time $t(t_0<t<t_3)$ is given by

$$Q(t) = \int_{t_0}^{t} [\lambda(s) - \mu]\, ds. \qquad (*)$$

It is claimed that this approach gives approximate answers to "many important practical problems." Some applications are also indicated. Diffusion approximations for $Q(t)$ are discussed in chapters 6 and 7, the starting point being the equation (*) with μ now a function of s. The discussion here is rather vague; in particular the transition from a deterministic formulation such as (*) to a stochastic one is not clear.

Stochastic models for queues are described in chapters 4 and 5. Approximations are considered in chapter 4 and equilibrium distributions in chapter 5. The final chapter 7 contains a review of the previous chapters and further comments.

From the above brief review of the contents it is clear that a more appropriate title for the book would have been "Naive Queuing Theory." It is presumably addressed to engineers who (according to the author) never need to "know a result exactly in a mathematical sense." Yet it is curious that this book is published in a series on applied probability and statistics.

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M. MANESCU, A. MACRIS, AND V. DIMITRU, *Metode Matematice Moderne Aplicate in Organizarea si Planificarea Lucrarilor de Constructii si Montaje (Modern Mathematical Methods Applied to Organising and Planning Plant Construction and Installation)*, Edit. Academiei Rep. Soc. Romania, Bucharest, Romania, 1969, 256 pages (paper)

M. MANESCU, V. DIMITRU, V. IONESCU, AND G. I. BARBATU, *Programarea Matematica in Industria Petroliera (Mathematical Programming in the Oil Industry)*, Edit. Academiei Rep. Soc. Romania, Bucharest, Romania, 1970, 272 pages (paper)

ALTHOUGH THESE two books written in Romanian may prove invaluable to the OR analyst in Romania where western books and journals may be rare, it is doubtful whether they have anything new to offer to the American reader; all of the OR methods covered are equally well if not much better discussed in the many American texts in OR. One exception, however, may constitute the many examples and applications to problems from the construction and oil industry. In that sense, an outline of these applications may be of some general interest, since no similar

American texts exist, at least not to my knowledge. Moreover, this outline would also show the confidence of the Romanian Government in the great applied potential of the modern mathematical methods applied to organizational problems. Consequently, I will summarize below the content of these two books.

As the title would suggest, the first book discusses the main OR techniques applied today in Romania in the planning and scheduling of construction projects. In addition, the authors also discuss some of the problems associated with the management of organizational systems. Each method is introduced by a short theoretical exposition followed by simplified examples of its present applications.

As expected, the first and by far the largest chapter discusses applications of the methods associated with the theory of graphs. Such problems as maximal flow, shortest route, traveling salesman, etc., are considered and examples of their applications given. For example, it is shown how to calculate the maximal flow of excavated earth originating at various nodes of a railway network or how to calculate the sequence by which electrical lines in the various parts of the country are to be installed or regularly maintained so that the transportation costs of the construction equipment are minimized.

The assignment algorithm is then used to solve a problem of recruiting four crews to transport oxygen tanks by trucks from city A to city B and back. The daily schedule of the trips is very tight, each crew may be selected from either A or B, and there are minimum and maximum allowable waiting times between consecutive trips of the same crew. It is the crew waiting time away from the home base that is minimized.

A discussion on communication networks is followed by an application to the problem of scheduling the ordering and arrival at a given time of the needed material and equipment in a large construction project. The Euler graph and the Koenigsberg bridge problem are briefly discussed, and its theory is applied to the minimization problem of the walking time through all sections (for inspection) of a given warehouse. Finally, the first chapter closes with an elaborate example of the application of the PERT and CPM techniques to a construction project.

The second chapter concerns itself with the now classical transportation problems, while the third one discusses the elements of the queuing theory and its applications to some queuing systems. This discussion is then extended to the next chapter where the queuing problems are considered in conjunction with the theory of graphs and critical path method as applied to the large and complex problem of scheduling the preparation, production, and ordering of needed material and equipment in a large construction project. It is desired that the given project at no time be out of stock for critically needed materials and overstocked in others.

A brief discussion on dynamic programming given in chapter 5 is followed by discussions on inventory models in chapter 6, theory of games in chapter 7, and simulation techniques, work sampling, and Markov chains in the last one. The examples of their possible applications are very sketchy and over-simplified.

The second book concerns itself with the applications of linear programming to the oil industry. Because of the limited availability of similar material in the Romanian language, the authors spend the second half of the book in a relatively detailed although elementary discussion for the American reader of the linear programming technique, the general use of computers in OR (including flow charting), and a few pages on network analysis and dynamic programming. Only deterministic models are considered by the authors.

The first half of the book starts with the relatively simple though sometimes lengthy models of the distribution type, either investments to new structures in crude oil extraction or crude oil production within a group of oil fields. The authors continue then with a more elaborate discussion on the problems associated with the crude oil processing in a given refinery; costs are minimized for the case where minimum quantities of various petroleum products are to be produced or profits maximized when the quantity of each product type must be less than a given maximum. In the first case, the authors have also used parametric programming to analyze the minimal cost as a function of systematic increases in the future demands. Simplified mathematical models are then constructed for the overall production of an oil distilling installation or a refinery.

Another chapter discusses some of the now classical blend problems. Simple examples are given of various LP models used to optimize the blending of various constituents into various grades of car or aircraft gasoline or diesel or motor oil. A nonlinear model of the problem of ethylation by means of lead tetraethyl is then converted into a parametric linear programming one.

Finally, several transportation models are considered to minimize the transportation costs of the petroleum products involving several refineries, warehouses, and customers.

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Kenneth J. Arrow and F. H. Hahn, *General Competitive Analysis*, Holden-Day, San Francisco, Cal., 1971, 452 pages, $15.95.

William J. Baumol, *Economic Theory and Operations Analysis*, Third Ed., Prentice-Hall, Englewood Cliffs, N. J., 1972, 626 pages.

John R. Canada, *Intermediate Economic Analysis for Management and Engineering*, Prentice-Hall, Englewood Cliffs, N. J., 1971, 430 pages, $15.95.

Robert L. Childress, *Calculus for Business and Economics*, Prentice-Hall, Englewood Cliffs, N. J., 1972, 267 pages.

C. West Churchman, *The Design of Inquiring Systems*, Basic Books, New York, N. Y., 1972, 300 pages, $10.00.

F. N. David, *A. First Course in Statistics*, Hafner Publishing Co., New York, N. Y., 1971, 228 pages, $6.80 (paper).

John M. Dutton and William H. Starbuck, *Computer Simulation of Human Behavior*, John Wiley & Sons, New York, N. Y., 1971, 708 pages, $19.95.

Mohamed A. El-Hodiri, *Constrained Extrema Introduction to the Differentiable Case with Economic Applications*, Springer-Verlag, New York, N. Y., 1971, 130 pages, $4.90 (paper).

E. Freund, *Zeitvariable Mehrgrössensysteme*, Springer-Verlag, New York, N. Y., 1971, 160 pages, $5.50 (paper).

Paul B. Hagelschuer, *Theorie der Linearen Dekomposition*, Springer-Verlag, New York, N. Y., 1971, 191 pages, $5.50 (paper).

James A. Hanson, *Growth in Open Economies*, Springer-Verlag, New York, N. Y., 1971, 128 pages, $4.90 (paper).