QUARTERLY

OF

APPLIED MATHEMATICS

SUGGESTIONS CONCERNING THE PREPARATION OF MANUSCRIPTS FOR THE QUARTERLY OF APPLIED MATHEMATICS

The editors will appreciate the authors' cooperation in taking note of the following directions for the preparation of manuscripts. These directions have been drawn up with a view toward eliminating unnecessary correspondence avoiding the return of papers for changes, and reducing the charges made for "author's corrections."

Manuscripts: Papers should be submitted in original typewriting on one side only of white paper sheets and be double or triple spaced with wide margins. Marginal instructions to the printer should be written in pencil to distinguish them clearly from the body of the text.

The papers should be submitted in final form. Only typographical errors may be corrected in proofs; composition charges for all major deviations from the manuscript will be passed on to the author.

Titles: The title should be brief but express adequately the subject of the paper. The name and initials of the author should be written as he prefers; all titles and degrees or honors will be omitted. The name of the organization with which the author is associated should be given in a separate line to follow his name.

Mathematical Work: As far as possible, formulas should be typewritten; Greek letters and other symbols not available on the typewriter should be carefully inserted in ink. Manuscripts containing pencilled material other than marginal instructions to the printer will not be accepted.

The difference between capital and lower-case letters should be clearly shown; care should be taken to avoid confusion between zero (0) and the letter O, between the numeral one (1), the letter l and the prime ('), between alpha and a, kappa and k, mu and u, nu and v, eta and n.

The level of subscripts, exponents, subscripts to subscripts and exponents in exponents should be clearly indicated.

Dots, bars, and other markings to be set *above* letters should be strictly avoided because they require costly hand-composition; in their stead markings (such as primes or indices) which *follow* the letter should be used.

Square roots should be written with the exponent $\frac{1}{2}$ rather than with the sign $\sqrt{\ }$.

Complicated exponents and subscripts should be avoided. Any complicated expression that recurs frequently should be represented by a special symbol.

For exponentials with lengthy or complicated exponents the symbol exp should be used, particularly if such exponentials appear in the body of the text. Thus,

$$\exp \left[(a^2 + b^2)^{1/2}\right] \text{ is preferable to } e^{(a^2+b^2)^{1/2}}$$

Fractions in the body of the text and fractions occurring in the numerators or denominators of fractions should be written with the solidus. Thus,

$$\frac{\cos (\pi x/2b)}{\cos (\pi a/2b)} \text{ is preferable to } \frac{\cos \dfrac{\pi x}{2b}}{\cos \dfrac{\pi a}{2b}}$$

In many instances the use of negative exponents permits saving of space. Thus,

$$\int u^{-1} \sin u \, du \text{ is preferable to } \int \frac{\sin u}{u} \, du.$$

Whereas the intended grouping of symbols in handwritten formulas can be made clear by slight variations in spacing, this procedure is not acceptable in printed formulas. To avoid misunderstanding, the order of symbols should therefore be carefully considered. Thus,

$$(a + bx) \cos t \text{ is preferable to } \cos t(a + bx).$$

In handwritten formulas the size of parentheses, brackets and braces can vary more widely than in print. Particular attention should therefore be paid to the proper use of parentheses, brackets and braces. Thus,

$$\{[a + (b + cx)^n] \cos ky\}^2 \text{ is preferable to } ((a + (b + cx)^n) \cos ky)^2.$$

Cuts: Drawings should be made with black India ink on white paper or tracing cloth. It is recommended to submit drawings of at least double the desired size of the cut. The width of the lines of such drawings and the size of the lettering must allow for the necessary reduction. Drawings which are unsuitable for reproduction will be returned to the author for redrawing. Legends accompanying the drawings should be written on a separate sheet.

Bibliography: References should be grouped together in a Bibliography at the end of the manuscript. References to the Bibliography should be made by numerals between square brackets.

The following examples show the desired arrangements: (*for books*—S. Timoshenko, *Strength of materials*, vol. 2, Macmillan and Co., London, 1931, p. 237; *for periodicals*—Lord Rayleigh, *On the flow of viscous liquids, especially in three dimensions*, Phil. Mag. (5)36, 354–372(1893). Note that the number of the series is not separated by commas from the name of the periodical or the number of the volume.

Authors' initials should precede their names rather than follow it.

In quoted titles of books or papers, capital letters should be used only where the language requires this. Thus, *On the flow of viscous fluids* is preferable to *On the Flow of Viscous Fluids*, but the corresponding German title would have to be rendered as *Über die Strömung zäher Flüssigkeiten*.

Titles of books or papers should be quoted in the original language (with an English translation added in parentheses, if this seems desirable), but only English abbreviations should be used for bibliographical details like ed., vol., no., chap., p.

Footnotes: As far as possible, footnotes should be avoided. Footnotes containing mathematical formulas are not acceptable.

Abbreviations: Much space can be saved by the use of standard abbreviations like Eq., Eqs., Fig., Sec., Art., etc. These should be used, however, only if they are followed by a reference number. Thus, "Eq. (25)" is acceptable, but not "the preceding Eq." Moreover, if any one of these terms occurs as the first word of a sentence, it should be spelled out.

Special abbreviations should be avoided. Thus "boundary conditions" should always be spelled out and not abbreviated as "b.c.," even if this special abbreviation is defined somewhere in the text.

CONTENTS

Nonparametric sequential selection procedures. By H. Buringer, H. Martin and K.-H. Schriever. Birkhauser Boston, Inc., 1980. viii + 488 pp. $24.50.

A selection procedure or selection model is a statistical experiment designed for identifying the best of several alternatives, and the statistical methods included in this book allow one to select the best alternative whenever there is any substantial difference among them. The book contains essentially the research results of the past ten years. It is designed primarily for scientists with strong mathematical backgrounds interested in new developments of applied statistics. All selection models have been supplemented by detailed results. Contents: Part I, Sequential procedures for selecting the best of $k \geq 2$ binomial populations: 1. Selection procedures with unrestricted patient horizon, 2. Selection procedures with restricted patient horizon, 3. Selection procedures with fixed patient horizon. Part 2, Continuous response selection models: 1. Subset-selection procedures based on linear rank-order statistics, 2. Asymptotic distribution-free sequential selection procedures based on an indifference-zone model, 3. Methods for selecting an optimal score function.

Nonlinear optimization, theory and algorithms. Edited by L. C. W. Dixon, E. Spedicato and G. P. Szego. Birkhauser Boston, Inc, 1980. 492 pp. $29.80.

These are the proceedings of an International Summer School held at the University of Bergamo, Italy, in September 1979 and repeated at the Hatfield Polytechnic, England, in July 1980. The papers are divided into three parts: 1. Unconstrained optimization (8 papers), 2. Constrained optimization (5 papers), 3. Related topics (5 papers). Chapter 1 is an introduction to numerical optimization by L. C. W. Dixon.

Ring theory and algebra III. (Lecture Notes in Pure and Applied Mathematics Series, Volume 55.) Edited by Bernard McDonald. Marcel Dekker, Inc, New York, 1980. 448 pp. $49.75.

This volume presents the proceedings of the third Algebra and Ring Theory Conference held at The University of Oklahoma, March 15–17, 1979. The papers provide a historical perspective and extensive references, as well as representing a cross-section of topics in algebra and commutative and noncommutative ring theory.

Symmetry : an analytical treatment. By J. Lee Kavanau. Science Software Systems, Inc., Los Angeles, CA, 1980. xxx + 600 pp. $24.95.

The author, a professor of biology at the University of California, Los Angeles, explores in this original work on analytic geometry "the many and far-reaching geometrical applications of symmetry and inversion analyses". It is a taxonomy of curves and their transformations and the author has found it necessary to devise scores of terms for new curves, types of equations, procedures, properties, coordinate systems, foci, focal conditions, etc. In the interests of paralleling the biological nomenclature of classification, he uses the taxa—subspecies, species, genus, family, superfamily, suborder, order, class, phylum, etc. The work is designed to be comprehensive to college students, so the discussion is detailed and discursive, and often heuristic. The fourteen chapters are divided into three parts: 1. Coordinate systems and circumpolar symmetry; 2. Circumpolar symmetry analyses; 3. The how and why of circumpolar symmetry. There are five appendices, including a glossary of terms, and a bibliography and index.

On the asymptotic analysis of large-scale ocean circulation. By W. P. M. De Ruijter. Mathematisch Centrum, Amsterdam, 1980. iii + 116 pp. Dfl. 14.

This is Mathematical Centre Tract 120. Chapter headings: 1. Introduction; 2. Models of the large-scale ocean circulation; 3. The method of analysis; 4. Some elementary models in the theory of the large-scale ocean circulation; 5. The Antarctic circumpolar current; 6. The return Agulhas current; 7. The circulation in ocean basins when a part of the boundary is a characteristic.

Algorithms for network programming. By Jeff L. Kennington and Richard V. Helgason. John Wiley and Sons, New York, 1980. xiii + 291 pp. $23.50.

This book presents both descriptions of and mathematical justification for the special-purpose algorithms used in a variety of network models. Chapter headings: 1. Introduction; 2. Linear programming; 3. The simplex method for the network program; 4. The out-of-kilter algorithm for the network program; 5. The simplex method for the generalized network problem; 6. The multicommodity network flow problem; 7. The simplex method for the network with side constraints model; 8. The convex cost network flow problem; Appendices.

Structure sheaves over a noncommutative ring. By J. S. Golan. Marcel Dekker, Inc., New York, 1980. 192 pp. $24.75.

This book presents a coherent introduction to the topic, proceeding to current work in the field where the goal is the elucidation of algebraic results by geometric interpretation and the application of geometric tools to prove new algebraic theorems.

Adaptive control: the model reference approach. By Yoan D. Landau. Marcel Dekker, Inc., New York, 1979. 432 pp. $45.00.

This is volume 8 in the Control and Systems Theory Series. The design of high-performance control systems often demands the use of adaptive control techniques. The technique known as model reference adaptive systems (MRAS) is one of the most feasible approaches for the practical implementation of adaptive control systems. With material covering the theory, design and applications of MRAS, this book presents a comprehensive treatment of the subject. It provides a detailed coverage of various types of MRAS, the corresponding design methods and their application to relevant situations.

Methods and applications in adaptive control. Edited by H. Unbehauen. Springer-Verlag, Berlin, Heidelberg, New York, 1980. vi + 309 pp. $21.60.

This is volume 24 of Lecture Notes in Control and Information Science, being the proceedings of an international symposium held at the Ruhr University of Bochum, Germany, in March 1980. There are fourteen lectures under the heading Adaptive Control and ten lectures under the heading Applications of Adaptive Control.

Computer systems architecture. By Jean-Loup Baer. Computer Science Press, Potomac, Md, 1980. xiii + 626 pp. $22.95.

This book is a comprehensive study of computer architecture from the introductory level to advanced research concepts. Beginning with a historical survey of computer systems architecture, it covers the PMS notation, register transfer level languages, and Petri nets. Arithmetic algorithms are then considered in detail followed by a comprehensive treatment of CPU, memory, I/O, and control unit design. The author describes a complete hierarchy of machines from microcomputers to supercomputers, and covers stack processors and multiprocessor and array processor systems. The book culminates in a consideration of probable future trends in computer architecture. Contents: Historical survey of computer systems architecture; Description of computer systems; Arithmetic algorithms; Powerful central processors; The memory hierarchy; Management of the memory hierarchy; The control unit and microprogramming; Input-output; From microprocessors to superminicomputers; Supercomputers; Future trends in computer systems architecture.

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Identification of industrial processes. By N. S. Rajbman and V. M. Chadeev. Translated from
the Russian by F. W. Gerretsen. North-Holland Publishing Co., Amsterdam and New
York, 1978. xiv + 435 pp. $41.50.

This book is dedicated to modelling of industrial processes (identification theory), one of the new areas of
control theory. Methods for model building are explained systematically for a wide class of real industrial
processes. The majority of these methods were tested in several branches of industry (manufacturing of machines,
metallurgy, petrochemical industry and others), and on the solution of problems in biology, physiology and
medicine. In Chapter 1 introductory remarks on models and on the formulation of the identification problem are
presented. The next three chapters are dedicated to the problem of building models without memory as well as
models with linear and nonlinear dynamics. In Chapters 5 and 6 adaptive algorithms are considered for a discrete
and, in Chapter 7, a continuous model. Chapter 8 gives a description of algorithms for estimating the degree of
accomplishment for a model built for an industrial process. Chapter 9 is devoted to the technical means for
identification.

Bifurcation problems and their numerical solution. Edited by H. D. Mittelmann and H.
Weber. Birkhauser Verlag, Basel, Boston, Stuttgart, 1980. 243 pp. $24.00.

This is number 54 in the International Series of Numerical Mathematics, being the proceedings of a workshop
held in Dortmund, Germany, in January 1980. There are twelve papers, including a survey article by H. D.
Mittelmann and H. Weber, which also summarizes important applications of bifurcation and discusses some of its
basic ideas, problems and tools.

Numerical treatment of integral equations. Edited by J. Albrecht and L. Collatz. Birkhauser
Verlag, Basel, Boston, Stuttgart, 1980. 275 pp. $33.00.

This is volume 53 of the International Series of Numerical Mathematics, being the proceedings of a sympos-
ium held at the Mathematical Research Institute, Oberwolfach, in November 1979. It covers the following topics:
Volterra integral equations, Fredholm integral equations of the second kind, Fredholm integral equations of the
first kind in connection with ill-posed problems, integrodifferential equations and branching problems with
non-linear integral equations.

Basic techniques of combinatorial theory. By Daniel I. A. Cohen. John Wiley and Sons, New
York, 1978. x + 323 pp. $18.75.

This book is intended as an introduction to combinatorial theory for the beginning student whose only
mathematical background is a semester of calculus. Chapter headings: 1. Introduction; 2. Binomial coefficients; 3.
Generating functions; 4. Advanced counting numbers; 5. Two fundamental principles; 6. Permutations; 7.
Graphs.

Group theory made easy for scientists and engineers. By Nyayapathi V. V. J. Swamy and
Mark A. Samuel. John Wiley & Sons, New York, 1979. vii + 174 pp. $14.50.

This book is designed for a one-semester course for students who had courses in calculus, elementary linear
algebra, and modern physics or introductory quantum mechanics, to impart familiarity with the "tool of sym-
metry" without proofs and with the help of examples.

Regression analysis and its application : a data-oriented approach. (Statistics: Textbooks and Monographs Series, Volume 34.) By Richard F. Gunst and Robert L. Mason. Marcel Dekker, Inc., New York, 1980. 424 pps. $39.75.

In this book, regression analysis is viewed in the general context of data analysis. Understanding of data bases, how data are collected, restrictions on the data, and consequences of ignoring the data base are stressed prior to the discussion of model definitions. The book relies on real data sets, and using a teach-by-example format, it presents 10 major data sets, and several smaller ones, to illustrate common characteristics of regression data and properties of statistics that are used in regression analysis. Chapter headings: 1. Introduction; 2. Initial data exploration; 3. Single-variable least squares; 4. Multiple-variable preliminaries; 5. Multiple-variable least squares; 6. Inference; 7. Residual analysis; 8. Variable selection techniques; 9. Multicollinearity effects; 10. Biased regression estimators; Appendices.

The classifying spaces for surgery and cobordism of manifolds. By I. B. Madsen and R. James Milgram. Princeton University Press, Princeton, 1979. xii + 279 pp. $20.00 (cloth); $8.50 (paper).

This is volume 92 in Annals of Mathematics Studies. It discusses classification results for piecewise linear and topological manifolds, topics which have formed one of the main lines of development for the past two decades in the area of algebraic and geometric topology and in which many of the major problems have recently been solved.

Statistical techniques for manpower planning. By D. J. Bartholomew and Andrew F. Forbes. John Wiley & Sons, New York, 1979. xiii + 288 pp. $37.50.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. It is a practical book on statistical methods which are now available to solve real-life problems in manpower planning. It sets out to be an instruction manual and contains many worked examples and problems for solution. Contents: 1. Statistics and manpower planning; 2. Analysis of wastage I: rates and life-table methods; 3. Analysis of wastage II: modelling, prediction, and measurement; 4. Transition models based on the theory of Markov chains; 5. Transition models based on renewal theory; 6. Career patterns; 7. Stationarity and control; 8. Statistical techniques for demand forecasting.

Introduction to global analysis. By Donald W. Kahn. Academic Press, Inc., New York, 1980. ix + 336 pp. $34.50.

From the preface: " The classical tradition of mathematical analysis studies functions, vector fields, differential equations, etc., in Euclidean space $\mathbb{R}^n$. It has become apparent in recent years that there is great interest in the methods of mathematical analysis carried out on manifolds, that is, spaces that look like $\mathbb{R}^n$ in the small. They have found concrete applications to the fields of physics, engineering, and economics; possible applications are under investigation in many other areas. The present book aims at making much of this material available to anyone who is at the level of a beginning graduate student in mathematics. The first half of the book requires little more than a good foundation in undergraduate mathematics. In later chapters we use some integration, Fourier analysis, and homology theory. At appropriate places, we outline all the theory that we need, and we list many references. In the Introduction we sketch the history of the subject and give a detailed description of the individual chapters. A full list of references is given at the end of the book." Chapter headings: 1. Manifolds and their maps; 2. Embeddings and immersions of manifolds; 3. Critical values, Sard's theorem and transversality; 4. Tangent bundles, vector bundles, and classification; 5. Differentiation and integration on manifolds; 6. Differential operators on manifolds; 7. Infinite-dimensional manifolds; 8. Morse theory and its applications; 9. Lie groups; 10. Dynamical systems; 11. A description of singularities and catastrophes.

Control and dynamic systems : advances in theory and application, Volume 16. Edited by C. T. Leondes. Academic Press, New York, 1980. xvii + 371 pp. $27.50.

This volume contains the following review articles: Gradient algorithms for the optimization of dynamic systems, by A. Miele; Model methods in optimal control synthesis, by Arthur E. Bryson, Jr., and W. Earl Hall, Jr.; Linear time-invariant robust servomechanism problem: a self-contained exposition, by C. A. Desoer and Y. T. Wang; Parameter identification of linear discrete stochastic systems with time delays, by Edward C. Wong; UDU^T covariance factorization for Kalman filtering, by Catherine L. Thornton and Gerald J. Bierman; Direct recursive estimation of noise statistics, by Katsumi Ohnishi; Modern techniques for the simulation of large closed-loop systems, by William D. Wade; Optimal low-order feedback controllers for linear discrete-time systems, by John O'Reilly.

Unsolvable classes of quantificational formulas. By Harry R. Lewis. Addison-Wesley Publishing Co., Massachusetts, 1979. xv + 198 pp. $13.50.

This book will be of interest to logicians, for its analysis of the fine structure of quantification theory, and to theoretical computer scientists and combinatorial mathematicians, for its treatment of decision problems outside as well as within logic. It assumes a level of mathematical sophistication—although it is mostly self-contained—and will hence be useful on the graduate level.

Computational probability. Edited by P. M. Kahn. Academic Press, Inc., New York, 1980. xi + 340 pp. $21.00.

This volume is a collection of papers presented at the Actuarial Research Conference on Computational Probability and related topics held at Brown University, August 28–30, 1975. The conference was sponsored jointly by the Committee on Research of the Society of Actuaries and the Division of Applied Mathematics of Brown University. The cochairmen of the conference were Walter Freiberger and David G. Halmstad. The principal objective of the conference was to explore the development of computational techniques in probability and statistics and their application to problems in insurance. Papers may be grouped under the six general topics: computational probability, computational statistics, computational risk theory, analysis of algorithms, numerical methods, and notation and computation. Applications covered both life and nonlife insurance. The volume is dedicated to the memory of the late David Garrick Halmstad, Secretary to the Committee on Research of the Society of Actuaries, who was instrumental in having the conference take place.

Information linkage between applied mathematics and industry. Edited by Peter C. C. Wang with Arthur L. Schoenstadt, Bert I. Russak and Craig Comstock. Academic Press, New York, 1979. xiv + 661 pp. $35.00.

This book contains the proceedings of a symposium held in February 1978, sponsored by the Office of Naval Research. It contains a keynote address by its then technical director Robert J. Lundegard and invited papers by L. A. Bruckner, Herman Chernoff, Herbert B. Keller, Victor Klee, Alan G. Konheim, Carol M. Newton, Herbert E. Rauch, Oeter C. C. Wang and Gerald E. Lake, and Philip Wolfe. There are also forty contributed papers, grouped under the headings: differential equations, finite mathematics, optimization and stochastic modeling. The aim of the symposium was to bring applied mathematicians and engineers together to exchange ideas, in the hope that it would "create opportunities for mathematicians to be aware of more practical engineering problems, and for engineers to realize useful mathematical techniques that are sometimes obtainable through the help of mathematicians."

Electromagnetism : principles and applications. By Paul Lorrain and Dale R. Corson. W. H. Freeman & Co., San Francisco, 1979. xiv + 507 pp. $12.50.

This volume is based on the second edition of *Electromagnetic fields and waves* by the same authors, published in 1970 (first edition: 1962), and is intended for courses at the freshman or sophomore level.

Combinatorics, representation theory and statistical methods in groups. Edited by T. V. Narayana, R. M. Mathsen, and J. G. Williams. Marcel Dekker, Inc., New York, 1980. 192 pp. $25.00.

The mathematicians whose work is represented in this volume have made significant contributions to their own fields and can be considered among the foremost of the sizeable group whose work has been motivated by Alfred Young's influence upon invariant theory, group representation theory and, in the four decades since his death, combinatorics and statistics. These papers are published here for the first time and include up-to-date research and review articles on combinatorics, representation theory, and statistical methods in groups, along with a lengthy article on the elementary theory of the symmetric group. The contents include an article by Professor G. de B. Robinson shedding new light on Alfred Young's life and unfinished work.

Algorithmes et pratique de programmation lineaire. (Algorithms and practice of linear programming). By P. Chretienne, Y. Pesqueux and J. C. Grandjean. Librairie Technip, Paris, 1980. 352 PP. FF 250.

The theoretical presentation of the algorithms is based solely on simple mathematical concepts, and illustrations are provided by practical exercises in different fields (management, finance, industry). The programming aspect of the subject is analyzed in detail so as to enable users to deal with their own problems. This book is intended for businessmen, decision makers, students and scientists in all disciplines having to formulate problems in terms of linear programming and to find ways of solving them. The aim of the book is to provide an instrument for help in decision making which is immediately usable, and this is why so many cases are included and solved. There are ten chapters in the book. Each chapter carries the reader one step further in understanding the method. After a simple review of linear algebra, it gives a glimpse of geometric reasoning and presents the algebraic solution before arriving at the concept of duality. Chapter 7 occupies a pivotal position in the book because it contains an organization of data and a scheduling of computing that is both simple and systematic. The book concludes with a presentation of the revised form of a simplex and the primal-dual method. At the end the reader will find a computer program so that larger-size problems can be handled.

Progress in cybernetics and systems research, vol. VII. Edited by F. R. Pickler and R. de P. Hanika. Hemisphere Publishing Corp., Washington, D.C., 1980. ix + 393 pp. $50.00.

These are the proceedings of the Linz, Austria, 1978 European Meeting on Cybernetics and Systems Research. It contains the contributions to the three symposia: general systems methodology, chaired by George J. Klir; organization and management, chaired by F. de P. Hanika; cognition and learning, chaired by Gordon Pask. Each of the symposia carries an introduction by its chairman, and there is a keynote introduction by René Thom, entitled "Systematic versus morphological approach in general system theory." There are 48 contributed papers.

An introduction to the mathematical theory of geophysical fluid dynamics. By Susan Friedlander. North-Holland Publishing Co., Amsterdam and New York, 1980. 282 pp. $29.50.

Geophysical fluid dynamics is the study of fluid motions on the earth. The purpose of this work is to give a mathematical description of a certain class of such phenomena. The author is concerned with those problems for which the length scale is sufficiently large that the earth's rotation has a significant effect on the dynamics of the fluid.

The computer from Pascal to von Neumann. **By Herman H. Goldstine. Princeton University Press, Princeton, N.J., 1980. x + 378 pp. $6.95.**

This is a paperback edition of the book first published in 1972.

Modeling and differential equations in biology. (Lecture Notes in Pure and Applied Mathematics, Volume 58.) Edited by T. A. Burton. Marcel Dekker, Inc., New York, 1980. 296 pp. $35.00.

This book contains twelve papers of original research on the applications of differential equations to biology. They describe how the stability theory of differential equations is being used in the modeling of microbial competition, predator-prey systems, **humoral** immune response, and dose and cell-cycle effects in radiotherapy, among other areas that involve immunology, population biology, and mathematical ecology.

Deterministic mathematical models in population ecology. (Pure and Applied Mathematics: A Series of Monographs and Textbooks, Volume 57.) By H. I. Freedman. Marcel Dekker, Inc., New York, 1980. 270 pp. $29.75.

The focus of this monograph is primarily on the dynamics aspects of mathematical ecology as they are derived from autonomous ordinary differential equations. It contains three main sections. The first section is concerned with single species growth; the second covers predator-prey models, and the third covers models of competition and cooperation. Each chapter contains an analysis of the historical background of the models presented, exercises of varying degrees of difficulty and an annotated account of the literature on the mathematical analysis of population biology. There is an extensive bibliography.

Practical methods of optimization, vol. 1 : unconstrained optimization. By R. Fletcher. John Wiley & Sons, Inc., 1980. viii + 120 pp. $24.50.

This is the first volume of a two-volume work which presents those aspects of optimization currently of foremost importance in solving practical problems. This involves a study of optimality criteria, determination of suitable algorithms, the study of the structure of such algorithms, and computer experimentation both under trial conditions and from real-life experience. Volume 1 is devoted to unconstrained optimization and starts by examining the overall structure of methods. It covers such techniques as quasi-Newton, conjugate gradient, and Levenberg-Marquardt methods amongst others. The associated subjects of nonlinear least-squares, data fitting, and nonlinear equations are also studied in some detail.

Cluster analysis algorithms for data reduction and classification of objects. By Helmuth Späth. Translated by Ursula Bull. Ellis Horwood Publishers, Chichester, New York, 1980. 226 pp. $56.95.

This book presents the current state of the art in practical cluster analysis, introducing and comparing a wide variety of algorithms used to group together objects of similar characteristics as an aid to classification and data reduction. All the necessary theoretical background is included. The most important algorithms are given in the form of Fortran subroutines, and are hence suitable for a wide range of computers. Examples are given of the use of subroutines in programs, with tables and diagrams of results. There is also a section on absolute distance criteria in partitioning cluster algorithms. The author introduces many problems from real-life situations where cluster analysis techniques are used in a wide range of applications, including medicine, psychology, engineering, geology, and the social sciences.

Introduction to control theory including optimal control. By D. N. Burges and A. Graham. John Wiley & Sons, Inc. New York, 1980. 400 pp. $67.50.

This introduction to both classical and modern control theory concentrates on fundamental concepts. It investigates applications of control theory to problems such as economic growth, resource depletion, disease epidemics, exploited populations, and rocket trajectories. The work is divided into two parts. Part 1 deals with the control of linear time-continuous systems, using both transfer function and state-space methods and discussing the ideas of controllability, observability and minimality. Part 2 introduces the calculus of variations, followed by analysis of continuous optimal control problems.

Singuläre Integral-Operatoren (Singular integral operators). By S. G. Michlin and S. Prössdorf. Akademic Verlag, Berlin, 1980. 514 pp. 96.00 DM.

This is volume 52 of the series Mathematische Lehrbücher und Monographen. Table of Contents (translated): 1. Auxiliary material from functional analysis; 2. The one-dimensional singular integral; 3. One-dimensional singular integral equations with continuous coefficients on closed curves; 4. One-dimensional singular integral equations with discontinuous coefficients; 5. Systems of one-dimensional singular equations; 6. One-dimensional singular equations with degenerate kernel; 7. Some problems leading to singular integral equations; 8. Further auxiliary material; 9. Multidimensional singular integrals in spaces with uniform metric; 10. The kernel of multidimensional singular integral operators; 11. Singular integral operators in spaces with integral metric; 12. Multidimensional singular integral equations; 13. Singular equations on smooth manifolds without boundary; 14. Systems of multidimensional singular equations; 15. The locality principle; singular operators on manifolds with boundary. 16. Multidimensional singular equations with degenerate kernel; 17. Methods of approximate solution of one-dimensional singular integral equations; 18. Approximate solution of multidimensional singular integral equations.

The mathematical theory of quantitative genetics. By M. G. Bulmer. Clarendon Press, Oxford, 1980. x + 254 pp. $74.00.

Many characters of agricultural and biological importance, such as milk yield in cows, present a continuous range of variability. Quantitative genetics is the study of the inheritance of such continuous, quantitative characters. It provides the bridge between the observable statistical properties of a character and the genetic factors which, together with environmental factors, are postulated to determine its expression.

The topics covered in this book are as follows: classical, Mendelian genetics; the joint role of genotype and environment in determining phenotypic values; the decomposition of the genotypic value into components representing various types of gene action; estimation of the components of variance and similiar quantities generated by this decomposition; the effect of selection; applications of selection theory in animal and plant breeding and in evolutionary theory; stochastic effects due to finite population size.

The emphasis is on discussion of the underlying principles, illustrated by simple examples. The reader is assumed to have some knowledge of statistical methods and theory, but the author has tried to make the book intelligible to the biologist with some statistical experience as well as to the statistician. Problems for solution are included.

Special topics of applied mathematics: functional analysis, numerical analysis and optimization. Edited by J. Frehse, D. Pallaschke and U. Trottenberg. North-Holland Publishing Co., Amsterdam and New York, 1980. viii + 242 pp. $39.00.

This volume contains most of the lectures of an international seminar held at the Gesselschaft für Mathematik und Datenverarbeitung in October 1979. The seminar was held on the event of the retirement of Professor Dr.-Ing. Heinz Unger, the founder of the GMD.

Numerical solution of systems of nonlinear equations. By J. C. P. Bus. Mathematical Centre Tracts 122. Mathematisch Centrum, Amsterdam 1980. vi + 205 pp. plus appendices. Dfl. 32.00.

In this monograph the author treats the problem of analysis and design of methods for the numerical solution of systems of nonlinear equations. He restricts attention to methods which can be classified as Newton-like; i.e., methods which require an initial estimate of a solution which is relatively close to an exact solution, in a sense which depends on the smoothness of the problem. These methods produce at most one approximation to a solution and for these methods the author presents a comprehensive convergence theory, which leads him to the construction of new Newton-like methods.

Regression diagnostics: identifying influential data and sources of collinearity. By D. A. Belsley, E. Kuh and R. E. Welsch. John Wiley & Sons, New York, 1980. xv + 292 pp. $21.95.

This book in the Wiley Series in Probability and Mathematical Statistics provides the practicing statistician and econometrician with new tools for assessing the quality and reliability of regression estimates. Diagnostic techniques are developed that 1) aid in the systematic location of data points that are either unusual or inordinately influential, and 2) measure the presence and intensity of collinear relations among the regression data, help to identify the variables involved in each, and pinpoint the estimated coefficients that are potentially most adversely affected. The primary emphasis of these contributions is on diagnostics, but suggestions for remedial action are given and illustrated. Chapter headings: 1. Introduction and overview; 2. Detecting influential observations and outliers; 3. Detecting and assessing collinearity; 4. Applications and remedies; 5. Research issues and directions for extensions.

Practical nonparametric statistics. 2nd edition. By W. J. Conover. John Wiley & Sons, New York, 1980. xiv + 493 pp. $25.95.

This volume in the Wiley Series in Probability and Mathematical Statistics is the second edition of the book first published in 1971. The essential format and substance are unchanged. There is a reorganization of the problems into theoretical and applied sections, the addition of review problems and more discussion of practical matters and of relationships between various, also parametric, tests. There is, in addition, the usual updating of material, e.g. robust methods for regression and experimental designs are introduced.

Mathematics and statistics for the biosciences. By G. Eason, C. W. Coles, and G. Gettinby. John Wiley & Sons, New York, 1980. 578 pp. $78.95.

This book provides an introduction to the mathematical knowledge and techniques required in the biological sciences.

Error-free computation: why it is needed and methods for doing it. By Robert T. Gregory. Krieger Publishing Co., Inc., New York, 1980. 152 pp. $7.50.

The author's purpose in writing this monograph is to acquaint mathematicians and computer scientists with some of the difficulties associated with attempts at approximating the arithmetic of the real field by using the (finite) set of floating-point numbers in an automatic digital computer, and the effects of these attempts at approximating real arithmetic on the numerical solution of ill-conditioned problems. In the first three chapters he discusses some of the differences between mathematics and numerical mathematics, including the effects of inexact floating-point arithmetic in attempting to solve ill-conditioned problems, as well as numerically stable and numerically unstable computational algorithms and the scaling problem for large systems of linear algebraic equations. In the last two chapters he introduces the results of recent attempts at eliminating the difficulties discussed in these earlier chapters by doing error-free arithmetic. Residue arithmetic (using a single modulus and also using several pairwise relatively prime moduli) is discussed in Chapter 4 and finite-segment p-adic arithmetic is discussed in Chapter 5. The treatment is expository and important results are stated without proof, for the most part, with specific references given to detailed proofs elsewhere.

Introduction to numerical analysis. By F. Stummel and K. Hainer. Translated by E. R. Dawson; edited by W. N. Everitt. Scottish Academic Press, Edinburgh, 1980. ix + 282 pp. $22.00.

This book is the English translation of *Praktische Mathematik*, published in 1971. It assumes a knowledge of differential and integral calculus and of the linear algebra of finite-dimensional vector spaces. It uses simple concepts from functional analysis such as vector space, norm, inner product and mapping. Consistency, stability and convergence in the solution of initial-value problems are emphasized. There are 12 chapters arranged in five groups: 1. Calculation of functions and zeros of functions; 2. Interpolation, extrapolation, numerical differentiation, and numerical interpolation; 3. Numerical methods of linear algebra; 4. Systems of non-linear equations and eigenvalue problems for matrices; 5. Numerical integration of initial-value problems for ordinary differential equations.

Applied linear regression. By Sanford Weisberg. John Wiley & Sons, New York, 1980. xii + 283 pp. $24.95.

This is a volume in the Wiley Series in Probability and Mathematical Statistics. It is a guide to the methodology for fitting linear models to data. The central themes are model building, assessing fit and reliability, and drawing conclusions. Standard regression topics, such as least squares estimation, and confidence and testing procedures are presented and illustrated through the use of examples. Residual analysis, choice of transformations for variables, and finding influential cases are covered in detail. Model building, including the definition of independent and dummy variables, and subset selection are discussed. The reasons for selecting a subset are emphasized; for the computations, analysis of all possible regressions is advocated rather than stepwise algorithms, and both are illustrated by example. Additional topics include statistics for investigating the sensitivity of results to measurement or rounding error in the independent variables, special considerations for prediction models, a discussion of modifications necessary for the analysis of incomplete data, and non-least-squares estimation methods.

Foundations of three-dimensional Euclidean geometry. By Izu Vaisman. Marcel Dekker, Inc., New York, 1980. 288 pp. $35.00.

This monograph provides a modern axiomatic construction of three-dimensional geometry. It presents a graduated formulation of axioms such that, by determining all the geometric spaces which satisfy the axioms considered, one may characterize the Euclidean space up to an isomorphism. A feature of this book is the introduction of the parallel axiom at an early stage of the discussion, so that the reader can see that results may be obtained both with and without this axiom.

Benefit-cost analysis of data used to allocate funds. By Bruce D. Spencer. Springer-Verlag, New York, 1980. viii + 296 pp. $16.80.

This is volume 3 of Lecture Notes in Statistics. It treats the question of determining how much to spend for the collection and analysis of public data. The approach taken is to estimate and compare the benefits and costs of alternative data programs.

Quantitative approximation. Edited by Ronald A. DeVore and Karl Scherer. Academic Press, New York, 1980. xi + 324 pp. $22.00.

These are the proceedings of an international symposium held in Bonn, West Germany, August 20–24, 1979. The following emerged as the main theses of the symposium: (i) n-widths, especially mixed-norm cases; (ii) spline approximation, with the most emphasis on multi-variate and knot independent questions; (iii) nonlinear approximation, including rational approximation and optimal knot spline approximation.

—BOOK REVIEWS—

Controlled diffusion processes. By N. V. Krylov. Springer Verlag, New York, 1980 (translation of the 1977 Russian edition). xii + 308 pp.

The book deals with the optimal control of diffusions $dx = b(\alpha(t, \omega), x, t)\, dt + \sigma(\alpha(t, \omega), x, t)\, dw$, where the control α takes values in a bounded convex set (no other convexity assumptions are used). The main emphasis is on the verification of the Bellman equation for the minimum cost functional. This is done via the use of many clever and sharp techniques for studying the smoothness and growth of the optimal cost functional, under quite weak conditions. The best results do use a uniform ellipticity condition, but many nice estimates are presented without this condition. The techniques normally involve approximating the optimization problem by a "smoothed" or "mollified" one, then using uniform estimates to study the limits. The methods are very nice; many have appeared in the Russian literature, but few have appeared in prior books. The book is probably the best current source dealing with the smoothness of the cost functionals and with the meaning of the Bellman equation. Optimization and imbedding theorems are used to great advantage in obtaining many of the estimates; e.g., to obtain a bound on the mean value of a functional of the diffusion, the problem is imbedded in a class of optimal control problems whose minimum cost functional is used to estimate the original functional. Approximation methods and Markov ε-optimal controls are also studied.

H. J. KUSHNER (*Providence*)

Stochastic filtering theory. By G. Kallianpur. Springer-Verlag, New York, 1980. xvi + 316 pp.

This very interesting and elegant book covers ground that is roughly equivalent to that in Lipster and Shiryaev, *Statistics of random processes I* (1977), namely the background and development of the modern theory of nonlinear filtering via martingale methods. Representation theorems for the conditional distribution and evolution equations for the conditional moments are obtained. (The first such equations for the nonlinear problem were obtained by Shiryaev and the reviewer independently.)

The book contains an introduction to the Wiener process and deals with the representation of functionals of the Wiener process, the Doob decomposition of square-integrable and local martingales, stochastic integrals with respect to martingales, the general Itô formula and stochastic differential equations (weak and strong solutions), the Girsanov theorem, measure transformations and properties of the multiple Wiener integral. The development of the nonlinear filtering theory with white Gaussian noise-corrupted observations follows roughly the lines developed by Kallianpur, Kunita and Fujisaki, and is an elegant exposition of that approach.

H. J. KUSHNER (*Providence*)

Encyclopedic dictionary of mathematics. By the Mathematical Society of Japan; edited by Shokichi Iyanaga and Yukiyosi Kawada, translation reviewed by Kenneth O. May, foreword by Saunders MacLane. Two volumes, 1975 pages. The MIT Press, Cambridge, Mass. and London, England, 1981. $40.00.

This is a paperback printing of the English translation first published (with new material) in 1977. The first Japanese edition was published in 1954 and the second in 1968. The translation project was managed by an advisory committee under the chairmanship of Edwin Hewitt. The result is that a unique and immensely valuable piece of scholarship is at last available to non-Japanese reading mathematicians. It contains exhaustive information about virtually all fields of mathematics on the level of advanced research, with many references appended to each article (and brought up to date in the translation with the Western reader in mind). The volumes represent a treasure-trove of material in a conveniently accessible form and have already proved to be a most valuable research aid to practicing mathematicians. This paperback edition, at its greatly reduced price, is therefore particularly to be welcomed.

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