

Series Editor, Shanti S. Gupta

Adaptive Statistical Procedures and Related Topics edited by John Van Ryzin

This volume comprises the proceedings of the Symposium on Adaptive Statistical Procedures and Related Topics held at Brookhaven National Laboratory in June 1985. The Symposium was held in honor of the 70th birthday of Herbert Robbins, Higgins Professor of Mathematical Statistics, Columbia University, and Senior Mathematician, Brookhaven National Laboratory. (The Symposium was supported by the National Science Foundation, the Army Research Office, the Air Force Office of Scientific Research, and the Department of Energy.)

TABLE OF CONTENTS

Sequential Analysis

- *On the Passage of a Random Walk from Generalized Balls* by S. Csörgö and L. Horváth
- *Convergence Rates for Iterative Solutions to Optimal Stopping Problems* by D. A. Darling
- *Computing Optimal Sequential Allocation Rules in Clinical Trials* by M. N. Katehakis and C. Derman
- *Sequential Analysis and the Law of the Iterated Algorithm* by H. R. Lerche
- *Multi-stage Tests of Hypotheses* by G. Lorden
- *A Multiple Criteria Optimal Selection Problem* by S. M. Samuels and B. Chotlos
- *On Bayes Tests for $p \leq 1/2$ versus $p > 1/2$: Analytical Approximations* by G. Simons and X. Wu
- *Sequential Confidence Intervals with Beta Protection in One-Parameter Families* by R. A. Wijsman
- *Confidence Sets for a Change-Point (Abstract)* by D. Siegmund
- *Asymptotic Optimality in Sequential Interval Estimation (Abstract)* by M. Woodroofe

Empirical Bayes Theory and Methods

- *Empirical Bayes Rules for Selecting Good Binomial Populations* by S. S. Gupta and T. Liang
- *The Finite State Compound Decision Problem, Equivariance and Restricted Risk Components* by D. C. Gilliland and J. F. Hannan
- *The Primal State Adaptive Control Chart* by B. Hoadley and B. Huston
- *Fully Nonparametric Empirical Bayes Estimation Via Projection Pursuit* by M. V. Johns
- *Empirical Bayes Estimation in Heterogeneous Matched Binary Samples with Systematic Aging Effects* by B. Levin
- *Empirical Bayes: A Frequency/Bayes Compromise* by C. N. Morris
- *Adaptive Allocation for Importance Sampling* by R. F. Peierls and J. A. Yahav
- *Empirical Bayes Procedures with Censored Data* by V. Susarla and J. Van Ryzin
- *Empirical Bayes Stock Market Portfolios (Abstract)* by T. M. Cover and D. H. Gluss

Stochastic Approximation Procedures

- *Stochastic Approximation for Functionals* by D. L. Hanson and R. P. Russo
- *Constrained Stochastic Approximation Via the Theory of Large Deviations* by H. Kushner and P. Dupuis
- *Stochastic Approximation and Adaptive Control* by T. L. Lai
- *Repeated-MLE Procedures for Stochastic Approximation in Quantal Response Problems* by T. Sellke
- *Maximum Likelihood Recursion and Stochastic Approximation in Sequential Designs* by C. F. J. Wu
- *Stochastic Approximation Revisited (Abstract)* by A. Dvoretzky

Related Topics: Statistics

- *Distribution Optimality and Second-Order Efficiency of Test Procedures* by R. R. Bahadur and J. C. Gupta
- *On Estimating the Total Probability of the Unobserved Outcomes of an Experiment* by P. J. Bickel and J. A. Yahav
- *Remarks on the Estimation of Coefficients of a Regression in the Presence of Unknown Explanatory Variables* by H. Chernoff
- *Estimation of the Median Survival under Random Censorship* by J. C. Gardiner, V. Susarla, and J. Van Ryzin
- *Maximum Likelihood Estimation in Regression with Uniform Errors* by H. Robbins and C. H. Zhang
- *Evaluating the Chosen Population: A Bayes and Minimax Approach* by H. Sackrowitz and E. Samuel-Cahn

Related Topics: Probability

- *Stochastic Differential Equations for Neuronal Behavior* by S. K. Christensen and G. Kallianpur
- *Optimization by Simulated Annealing: A Necessary and Sufficient Condition for Convergence* by B. Hajek
- *Ruelle's Perron-Frobenius Theorem and the Central Limit Theorem for Additive Functionals of One-Dimensional Gibbs States* by S. P. Lalley
- *Limit Theorems for Random Central Order Statistics* by M. L. Puri and S. S. Ralescu
- *On Moments of Ladder Height Variables (Abstract)* by Y. S. Chow

List price \$40.00
 IMS member price \$24.00

Order prepaid from:
Institute of Mathematical Statistics
3401 Investment Boulevard, Suite 7
Hayward, California 94545 (USA)



Series Editor, **Shanti S. Gupta****Fundamentals of Statistical Exponential Families
with Applications in Statistical Decision Theory***by Lawrence D. Brown*

Many if not most of the successful mathematical formulations of statistical questions involve specific exponential families of distributions. It is often informative and advantageous to view these mathematical formulations from the perspective of general exponential families. This volume provides a systematic treatment of the analytical and probabilistic properties of exponential families with a variety of statistical applications in mind. Exercises are provided at the end of each chapter.

CONTENTS

1. Basic Properties
Standard Exponential Families, Marginal Distributions, Reduction to a Minimal Family, Random Samples, Convexity Property, Conditional Distributions
2. Analytic Properties
Differentiability and Moments, Formulas for Moments, Analyticity, Completeness, Mutual Independence, Continuity Theorem, Total Positivity, Partial Order Properties
3. Parametrizations
Steep Families, Mean Value Parametrization, Mixed Parametrization, Differentiable Subfamilies
4. Applications
Information Inequality, Unbiased Estimates of the Risk, Generalized Bayes Estimators of Canonical Parameters, Generalized Bayes Estimators of Expectation Parameters; Conjugate Priors
5. Maximum Likelihood Estimation
Full Families, Non-Full Families, Convex Parameter Space, Fundamental Equation
6. The Dual to the Maximum Likelihood Estimator
Convex Duality, Minimum Entropy Parameter, Aggregate Exponential Families
7. Tail Properties
Fixed Parameter (Via Chebyshev's Inequality), Fixed Parameter (Via Kullback-Leibler Information), Fixed Reference Set, Complete Class Theorems for Tests (Separated Hypotheses), Complete Class Theorems for Tests (Contiguous Hypotheses)

Appendix to Chapter 4. Pointwise Limits of Bayes Procedures

References

Index

List price	\$25.00
IMS member price	\$15.00

Order prepaid from:
Institute of Mathematical Statistics
3401 Investment Boulevard, Suite 7
Hayward, California 94545 (USA)

Differential Geometry in Statistical Inference

*by S.-I. Amari, O. E. Barndorff-Nielsen, R. E. Kass, S. L. Lauritzen,
and C. R. Rao*

The papers collected here present, in a concise yet comprehensive form, several major developments of recent research on differential geometry in statistics.

Contents

Introduction by R. E. Kass

Differential Geometrical Theory of Statistics—Towards New Developments

by S.-I. Amari

Introduction; Geometrical Structure of Statistical Models; Higher-Order Asymptotic Theory of Statistical Inference in Curved Exponential-Family; Information, Sufficiency and Ancillarity Higher Order Theory; Fibre-Bundle Theory of Statistical Models; Estimation of Structural Parameter in the Presence of Infinitely Many Nuisance Parameters; Parametric Models of Stationary Gaussian Time Series; References

Differential and Integral Geometry in Statistical Inference by O. E. Barndorff-Nielsen

Introduction; Review and Preliminaries; Transformation Models; Transformation Submodels; Maximum Estimation and Transformation Models; Observed Geometries; Expansion of $|c_{jj}|^{1/2}$; Exponential Transformation Models; Appendices and References

Statistical Manifolds by S. L. Lauritzen

Introduction; Some Differential Geometric Background; The Differential Geometry of Statistical Models; Statistical Manifolds; The Univariate Gaussian Manifold; The Inverse Gaussian Manifold; The Gamma Manifold; Two Special Manifolds; Discussion and Unsolved Problems; References

Differential Metrics in Probability Spaces by C. R. Rao

Introduction; Jensen Difference and Entropy Differential Metric; The Quadratic Entropy; Metrics Based on Divergence Measures; Other Divergence Measures; Geodesic Distances; References

List price \$25

IMS member price \$15

Order prepaid from:

**Institute of Mathematical Statistics
3401 Investment Boulevard, Suite 7
Hayward, California 94545 (USA)**

INSTITUTE OF MATHEMATICAL STATISTICS
(Organized September 12, 1935)

*The purpose of the Institute is to foster the development and dissemination of the theory
and applications of statistics and probability.*

OFFICERS AND EDITORS

President:

Bradley Efron, Department of Statistics, Sequoia Hall, Stanford University, Stanford, California 94305

President-Elect:

Ram Gnanadesikan, Morris Research and Engineering Center, Bell Communications Research, 435 South Street, Morristown, New Jersey 07960-1961

Past President:

Ronald Pyke, Department of Mathematics GN-50, University of Washington, Seattle, Washington 98195

Executive Secretary:

Peter Purdue, Department of Operations Research, Code 55, Naval Postgraduate School, Monterey, California 93943

Treasurer:

Nicholas P. Jewell, Group in Biostatistics, University of California, Berkeley. *Please send correspondence to:* IMS Business Office, 3401 Investment Boulevard #7, Hayward, California 94545

Program Secretary:

Lynne Billard, Department of Statistics, University of Georgia, Athens, Georgia 30602

Editor: *The Annals of Statistics*

Willem R. van Zwet, Department of Mathematics, University of Leiden, P.O. Box 9512, 2300 RA Leiden, The Netherlands

Editor: *The Annals of Probability*

Thomas M. Liggett, Department of Mathematics, University of California, Los Angeles, California 90024

Executive Editor: *Statistical Science*

Morris H. DeGroot, Department of Statistics, Carnegie Mellon University, Pittsburgh, Pennsylvania 15213

Editor: *The IMS Bulletin*

George P. H. Styan, Department of Mathematics and Statistics, Burnside Hall, McGill University, 805 Sherbrooke Street West, Montreal PQ, Canada H3A 2K6

Editor: *The IMS Lecture Notes—Monograph Series*

Shanti S. Gupta, Department of Statistics, Purdue University, West Lafayette, Indiana 47907

Managing Editor:

Paul Shaman, Department of Statistics, University of Pennsylvania, Philadelphia, Pennsylvania 19104

Journals. The scientific journals of the Institute are *The Annals of Statistics*, *The Annals of Probability*, and *Statistical Science*. The news organ of the Institute is *The Institute of Mathematical Statistics Bulletin*.

Individual, Institutional, and Corporate Memberships. All individual members receive *Statistical Science* and *The IMS Bulletin* for a basic annual dues rate of \$30. Individual members may elect to receive one *Annals* for an additional \$10 or both *Annals* for an additional \$20. Dues allocations to each journal are set by Council resolution. Of the total dues paid, \$8 is allocated to *The IMS Bulletin* and the remaining amount is allocated equally among the scientific journals received. Memberships are available at a reduced rate (40% of regular rates) for full-time students, permanent residents of developing countries, and retired members. Retired members may also elect to receive the *Bulletin* only for \$10. *Institutional memberships* are available to nonprofit organizations at \$230 per year and *corporate memberships* are available to other organizations at \$500 per year. Institutional and corporate memberships include two multiple-readership copies of all IMS journals in addition to other benefits specified for each category (details available from the IMS Business Office).

Individual and General Subscriptions. Subscriptions are available on a calendar-year basis. For 1987, all subscriptions to one or both *Annals* automatically include one subscription to *Statistical Science*. *Individual subscriptions* are for the personal use of the subscriber and must be in the name of, paid directly by, and mailed to an individual. Individual subscriptions for 1987 are available to both *Annals* and *Statistical Science* (\$79), one *Annals* and *Statistical Science* (\$52), *Statistical Science* only (\$25), and *The IMS Bulletin* (\$15). *General subscriptions* are for libraries, institutions, and any multiple-readership use. General subscriptions for 1987 are available to both *Annals* and *Statistical Science* (\$160), one *Annals* and *Statistical Science* (\$85), *Statistical Science* only (\$40), and *The IMS Bulletin* (\$20). Air mail rates for overseas delivery of general subscriptions are \$40 per title.

Correspondence. Mail to IMS should be sent to the IMS Business Office (membership, subscriptions, claims, copyright permissions, advertising, back issues), the Editor of the appropriate journal (submissions, editorial content), or the Managing Editor (production).

Applied Probability

A Series of the Applied Probability Trust

Editors: J. Gani and C.C. Heyde

Springer-Verlag, in association with the Applied Probability Trust, is proud to announce the publication of a new series of books on applied probability. The series, listed and described below, offers the reader insight into current research and provides the motivation for a further examination of each topic.

New in the series . . .

Volume 5

Stopped Random Walks

Limit Theorems and Applications

Allan Gut

Classical probability theory provides information about random walks after a fixed number of steps. For applications, however, it is more natural to consider random walks evaluated after a *random* number of steps. Examples are sequential analysis, queueing theory, storage and inventory theory, insurance risk theory, reliability theory, and the theory of contours. **Stopped Random Walks**, the first unified treatment of this subject, shows how this theory can be used to prove limit theorems for renewal counting processes, first passage time processes, and certain two-dimensional random walks. Also shows how these results are useful in various applications.

1987/approx 224 pp/Cloth \$44.00
ISBN 0-387-96590-4

Volume 4

Extreme Values, Regular Variation, and Point Processes

Sidney I. Resnick

Here is a comprehensive, up-to-date, and readable account of the behavior of extreme values of phenomena based on independent, identically distributed (iid) random variables and vectors. Many of the topics appear here for the first time in book form. These include quality of convergence, behavior of record values, record value indices, k-records, applications of point process methods to convergence in distribution, extremal processes, and others. Students and research workers in probability, statistics, mathematics, operations research, civil engineering, and economics will find this book full of useful information.

1987/320 pp/Cloth \$69.00
ISBN 0-387-96481-9

Also available in the Applied Probability series . . .

Regeneration and Networks of Queues

Gerald S. Shedler

This book develops probabilistic and statistical methods for discrete event simulation of networks of queues. In this self-contained presentation, the author emphasizes the use of the underlying regenerative stochastic process structure for the design of simulation experiments and the analysis of simulation output. The estimation procedures and examples presented require only a familiarity with some aspects of elementary probability theory, statistics, and stochastic models.

1987/224 pp/15 illus/Cloth \$24.80
ISBN 0-387-96425-8

Series of Irregular Observations

Forecasting and Model Building

Robert Azencott and Didier Dacunha-Castelle

A compact and vigorous introduction to the essentials of spatial analysis and finite autoregressive and moving schemes (ARMA processes), this book explains the technique for the use of random stationary processes for the modeling of

numerous concrete phenomena. Addressed to probabilists, statisticians, and electrical engineers, **Series of Irregular Observations** is mathematically rigorous but restricts itself to one-dimensional processes in order to keep the basic concepts as transparent as possible.

1986/236 pp/Cloth \$32.00
ISBN 0-387-96263-8

The Craft of Probabilistic Modelling

A Collection of Personal Accounts

Edited by Joseph Gani

The subject of this book, the first in the series, is probabilistic models, how they are developed and how they are used. Through the personal accounts of 19 eminent applied probabilists, the book also outlines the many avenues which lead to the craft of probabilistic modelling. The contributors, many of them pioneers of applied probability, give an authentic and perceptive account of their craft.

1986/313 pp/21 illus/Cloth \$42.50
ISBN 0-387-96277-8



To order these or other Springer-Verlag titles, write to: Springer-Verlag New York, Inc., Attn: G. Kiely, 175 Fifth Avenue, New York, NY 10010. Checks, money orders (plus \$2.50 for shipping), and major credit cards are acceptable forms of payment. NY, NJ, and CA residents please add applicable sales tax. To order by telephone (in the US) call TOLL FREE 1-800-526-7254 (in NJ, 201-348-4033).

SPRINGER-VERLAG

New York

Berlin

Heidelberg

Vienna

London

Paris

Tokyo