

# THE ANNALS of STATISTICS

ISSN (0090-5364)

AN OFFICIAL JOURNAL OF  
THE INSTITUTE OF MATHEMATICAL STATISTICS

## Articles

- Asymptotics of graphical projection pursuit . . . . . PERSI DIACONIS AND DAVID FREEDMAN 793  
 A geometric approach to nonlinear regression diagnostics with application  
 to matched case-control studies  
     SURESH H. MOOLGAVKAR, EDWARD D. LUSTBADER AND DAVID J. VENZON 816  
 On bootstrapping two-stage least-squares estimates in stationary linear  
 models . . . . . D. FREEDMAN 827  
 Infinitesimal robustness for autoregressive processes . . . . . H. KÜNSCH 843  
 Parametric robustness: small biases can be worthwhile . . . . . P. J. BICKEL 864  
 Adaptive density flattening—a metric distortion principle for combating  
 bias in nearest neighbor methods . . . . . IAN S. ABRAMSON 880  
 The data-smoothing aspect of Stein estimates . . . . . KER-CHAU LI AND JIUNN TZON HWANG 887  
 Spline smoothing: the equivalent variable kernel method . . . . . B. W. SILVERMAN 898  
 Asymptotic normality of nearest neighbor regression function estimates  
     WINFRIED STUTE 917  
 A sharp necessary and sufficient condition for inadmissibility of  
 estimators in a control problem . . . . . C. SRINIVASAN 927  
 Optimal fixed size confidence procedures for a restricted parameter space  
     MEHMET ZEYTINGLU AND MAX MINTZ 945  
 Deriving posterior distributions for a location parameter: a decision  
 theoretic approach . . . . . CONSTANTINE A. GATSONIS 958  
 Adjustment by minimum discriminant information . . . . . SHELBY J. HABERMAN 971  
 Approximate likelihood and probability calculations based on transforms . . . . . ROLLIN BRANT 989  
 Optimality of balanced uniform repeated measurements designs . . . . . JOACHIM KUNERT 1006  
 Properties of biased coin designs in sequential clinical trials . . . . . RICHARD L. SMITH 1018  
 Bayes double sample estimation procedures  
     ARTHUR COHEN AND HAROLD B. SACKROWITZ 1035  
 Symmetric distributions for dependent unit vectors . . . . . LOUIS-PAUL RIVEST 1050  
 A general theory of asymptotic consistency for subset selection with  
 applications . . . . . JAN F. BJØRNSTAD 1058  
 Empirical Bayes with a changing prior . . . . . M. K. MARA AND J. J. DEELY 1071

## Short Communications

- Best attainable rates of convergence for estimates of parameters of regular  
 variation . . . . . PETER HALL AND A. H. WELSH 1079  
 On the information matrix for symmetric distributions on the hypersphere  
     LOUIS-PAUL RIVEST 1085  
 On the estimation of a convex set . . . . . MARC MOORE 1090  
 A characterization theorem for externally Bayesian groups . . . . . CHRISTIAN GENEST 1100  
 Rectangular regions of maximum probability content . . . . . S. KUNTE AND R. N. RATTIHALLI 1106  
 Results on double sample estimation for the binomial distribution  
     ARTHUR COHEN AND HAROLD B. SACKROWITZ 1109  
 Bounds for the Bayes risk for testing sequentially the sign of the drift  
 parameter of a Wiener process . . . . . ASHIM MALLIK AND YI-CHING YAO 1117  
 Asymptotic normality of a class of nonlinear rank tests for independence  
     SHINGO SHIRAHATA AND KAZUMASA WAKIMOTO 1124  
 A note on bootstrapping the sample median  
     MALAY GHOSH, WILLIAM C. PARR, KESAR SINGH AND G. JOGESH BABU 1130  
 Constrained simultaneous confidence intervals for multiple comparisons  
 with the best . . . . . JASON C. HSU 1136

## Book Review

- Book Review of *Aspects of Multivariate Statistical Theory*, by Robb J. Muirhead, and  
*Multivariate Statistics. A Vector Space Approach*, by Morris L. Eaton.  
     ROBERT A. WIJSMAN 1145

Vol. 12, No. 3—September 1984



# THE INSTITUTE OF MATHEMATICAL STATISTICS

(Organized September 12, 1935)

*The purpose of the Institute of Mathematical Statistics is to encourage the development, dissemination, and application of mathematical statistics.*

---

## OFFICERS

**President:**

Ingram Olkin, Department of Statistics, Sequoia Hall, Stanford University, Stanford, California 94305

**President-Elect:**

Oscar Kempthorne, Department of Statistics, Iowa State University, Ames, Iowa 50011

**Past President:**

Patrick Billingsley, Department of Statistics, University of Chicago, Chicago, Illinois 60637

**Executive Secretary:**

Kjell Doksum, Department of Statistics, University of California, Berkeley, California 94720

**Treasurer:**

Bruce E. Trumbo, Department of Statistics, California State University, Hayward, California 94542. *Send correspondence to:* IMS Business Office, 3401 Investment Blvd., Suite 6, Hayward, California 94545

**Program Secretary:**

Richard A. Johnson, Department of Statistics, University of Wisconsin, 1210 West Dayton St., Madison, Wisconsin 53706

**Editor:** *The Annals of Statistics*

Michael D. Perlman, Department of Statistics, GN-22, University of Washington, Seattle, Washington 98195

**Editor:** *The Annals of Probability*

Harry Kesten, Department of Mathematics, Cornell University, Ithaca, N.Y. 14853

**Editor:** *The IMS Bulletin*

William C. Guenther, Department of Statistics, University of Wyoming. *Send correspondence to:* Box 3332, University Station, Laramie, Wyoming 82071.

**Editor:** *IMS Lecture Notes-Monograph Series*

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

**Managing Editor:**

Prem K. Goel, Department of Statistics, The Ohio State University, Columbus, Ohio 43210

---

**Official Journals.** The official journals of the Institute are *The Annals of Statistics*, *The Annals of Probability*, and *The Institute of Mathematical Statistics Bulletin*.

**Individual and Institutional Memberships.** All *individual members* receive the *Bulletin*. Annual dues for individual membership depend upon the journals selected (\$52 for both *Annals*/ \$40 for one *Annals*). Dues allocations to each journal are set by Council resolution for regular members at \$6 for *The IMS Bulletin* and \$34 for one *Annals* or \$23 for each *Annals*. Subject to some restrictions, memberships are available at reduced rates for students (\$21/\$17), residents of developing countries (\$35/\$28), and retired members (\$11/\$6/\$1 for the *Bulletin* only). *Institutional memberships* are available at \$200 per year and include two copies for multiple readership of all three journals.

**Individual and General Subscriptions.** Subscriptions are available on a calendar year basis. *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 1984 are available to *The Annals of Statistics* (\$45), *The Annals of Probability* (\$45), and *The IMS Bulletin* (\$11).

*General subscriptions* are for libraries, institutions, and any multiple-readership use. General subscriptions for 1984 are available to *The Annals of Statistics* (\$66), *The Annals of Probability* (\$62), and *The IMS Bulletin* (\$20). Air mail rates for overseas delivery of general subscriptions are quoted upon request.

**Correspondence.** Mail to IMS should be sent to the Business Office (membership, subscriptions, claims, copyright permissions, advertising, back issues), the Editor of the appropriate journal (submissions, editorial content), or the Managing Editor (production), and *not* to Waverly Press.

**The Annals of Statistics**, (ISSN 0090-5364), Volume 12, Number 3, September, 1984. Published in March, June, September and December by the Institute of Mathematical Statistics, 3401 Investment Blvd, #6, Hayward, California 94545. Printed at the Waverly Press, Inc., Baltimore, Maryland 21202. Second-class postage paid at Hayward, California and at additional mailing offices. **Postmaster.** Send address changes to *The Annals of Statistics*, Institute of Mathematical Statistics, 3401 Investment Blvd, #6, Hayward, California 94545.

Copyright © 1984 by the Institute of Mathematical Statistics  
Printed in the United States of America

## EDITORIAL STAFF

EDITOR

MICHAEL D. PERLMAN

ASSOCIATE EDITORS

JAMES O. BERGER  
P. K. BHATTACHARYA  
LAWRENCE D. BROWN  
RAYMOND J. CARROLL  
JOHN J. CROWLEY  
DAVID F. FINDLEY  
STUART GEMAN  
SHELBY J. HABERMAN

PETER HALL  
STEFFEN L. LAURITZEN  
J. OOSTERHOFF  
DONALD A. PIERCE  
DAVID POLLARD  
FRIEDRICH PUKELSHEIM  
JOHN RICE  
B. W. SILVERMAN  
A. F. M. SMITH

J. MICHAEL STEELE  
KEI TAKEUCHI  
D. M. TITTERINGTON  
GÁBOR TUSNÁDY  
JON A. WELLNER  
MICHAEL WOODROOFE  
C. F. JEFF WU  
VICTOR J. YOHAI

INVITED PAPERS AND BOOK REVIEWS

C. F. JEFF WU

EDITORIAL ASSISTANT

CHAIM ROSEMARIN

MANAGING EDITOR

PREM K. GOEL

EDITORIAL ASSISTANTS

DOROTHY GARVIN TONJES

LINDALEE W. BROWNSTEIN

PAST EDITORS

ANNALS OF MATHEMATICAL STATISTICS

H. C. CARVER, 1930–1938  
S. S. WILKS, 1938–1949  
T. W. ANDERSON, 1950–1952  
E. L. LEHMANN, 1953–1955  
T. E. HARRIS, 1955–1958

WILLIAM KRUSKAL, 1958–1961  
J. L. HODGES, JR., 1961–1964  
D. L. BURKHOLDER, 1964–1967  
Z. W. BIRNBAUM, 1967–1970  
INGRAM OLKIN, 1970–1972

ANNALS OF STATISTICS

INGRAM OLKIN, 1972–1973  
I. R. SAVAGE, 1974–1976  
RUPERT G. MILLER, JR., 1977–1979  
DAVID V. HINKLEY, 1980–1982

ANNALS OF PROBABILITY

RONALD PYKE, 1972–1975  
PATRICK BILLINGSLEY, 1976–1978  
R. M. DUDLEY, 1979–1981

## EDITORIAL POLICY

The main purpose of *The Annals of Statistics* and *The Annals of Probability* is to publish significant contributions to the theory of statistics and probability and their applications. The emphasis is on importance and interest; formal novelty and mathematical correctness alone are not sufficient for publication. Especially appropriate are authoritative expository papers and surveys of areas in vigorous development. Because statistics is an evolving discipline, the Editors of the *Annals of Statistics* take a broad view of its domain and welcome papers in interface areas. Contributors to the *Annals of Statistics* should review the editorial in the January 1980 issue. All papers are refereed.

## IMS INSTITUTIONAL MEMBERS

**AEROSPACE CORPORATION**  
El Segundo, California

**ARIZONA STATE UNIVERSITY**  
Tempe, Arizona

**BELL COMMUNICATIONS RESEARCH**  
Murray Hill, New Jersey

**BOWLING GREEN STATE UNIVERSITY, DEPARTMENT OF MATHEMATICS AND STATISTICS**  
Bowling Green, Ohio

**CALIFORNIA STATE UNIVERSITY, FULLERTON, MATHEMATICS DEPARTMENT, MANAGEMENT SCIENCE DEPARTMENT**  
Fullerton, California

**CASE WESTERN RESERVE UNIVERSITY, DEPARTMENT OF MATHEMATICS**  
Cleveland, Ohio

**CORNELL UNIVERSITY, DEPARTMENT OF MATHEMATICS**  
Ithaca, New York

**FLORIDA STATE UNIVERSITY, DEPARTMENT OF STATISTICS**  
Tallahassee, Florida

**GENERAL MOTORS CORPORATION, RESEARCH LABORATORIES**  
Warren, Michigan

**GEORGE WASHINGTON UNIVERSITY, DEPARTMENT OF STATISTICS**  
Washington, D.C.

**INDIANA UNIVERSITY, MATHEMATICS DEPARTMENT**  
Bloomington, Indiana

**INTERNATIONAL BUSINESS MACHINES CORPORATION**  
Armonk, New York

**IOWA STATE UNIVERSITY, STATISTICAL LABORATORY**  
Ames, Iowa

**JOHNS HOPKINS UNIVERSITY, DEPARTMENT OF BIostatISTICS, DEPARTMENT OF MATHEMATICAL SCIENCES**  
Baltimore, Maryland

**KANSAS STATE UNIVERSITY, STATISTICS DEPARTMENT**  
Manhattan, Kansas

**MARQUETTE UNIVERSITY, MATHEMATICS AND STATISTICS DEPARTMENT**  
Milwaukee, Wisconsin

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY MATHEMATICS DEPARTMENT**  
Cambridge, Massachusetts

**MIAMI UNIVERSITY, DEPARTMENT OF MATHEMATICS**  
Oxford, Ohio

**MICHIGAN STATE UNIVERSITY, DEPARTMENT OF STATISTICS AND PROBABILITY**  
East Lansing, Michigan

**NATIONAL SECURITY AGENCY**  
Fort George G. Meade, Maryland

**NEW MEXICO STATE UNIVERSITY, DEPARTMENT OF MATHEMATICAL SCIENCES**  
Las Cruces, New Mexico

**NORTH CAROLINA STATE UNIVERSITY, DEPARTMENT OF STATISTICS**  
Raleigh, North Carolina

**NORTHERN ILLINOIS UNIVERSITY, DEPARTMENT OF MATHEMATICAL SCIENCES**  
De Kalb, Illinois

**NORTHWESTERN UNIVERSITY, DEPARTMENT OF MATHEMATICS**  
Evanston, Illinois

**OHIO STATE UNIVERSITY, DEPARTMENT OF STATISTICS**  
Columbus, Ohio

**OREGON STATE UNIVERSITY, DEPARTMENT OF STATISTICS**  
Corvallis, Oregon

**PENNSYLVANIA STATE UNIVERSITY, DEPARTMENT OF STATISTICS**  
University Park, Pennsylvania

**PRINCETON UNIVERSITY, DEPARTMENT OF STATISTICS**  
Princeton, New Jersey

**PURDUE UNIVERSITY LIBRARIES**  
Lafayette, Indiana

**QUEEN'S UNIVERSITY, DEPARTMENT OF MATHEMATICS AND STATISTICS**  
Kingston, Ontario, Canada

**RICE UNIVERSITY, DEPARTMENT OF MATHEMATICAL SCIENCES**  
Houston, Texas

**THE ROCKEFELLER UNIVERSITY**  
New York, New York

**SIMON FRASER UNIVERSITY, MATHEMATICS DEPARTMENT**  
Burnaby, Canada

**SOUTHERN ILLINOIS UNIVERSITY, MATHEMATICAL STUDIES**  
Edwardsville, Illinois

**SOUTHERN METHODIST UNIVERSITY, DEPARTMENT OF STATISTICS**  
Dallas, Texas

**STANFORD UNIVERSITY, GIRSHICK MEMORIAL LIBRARY**  
Stanford, California

**STATE UNIVERSITY OF NEW YORK, BUFFALO, DEPARTMENT OF STATISTICS**  
Amherst, New York

**TEMPLE UNIVERSITY, MATHEMATICS DEPARTMENT**  
Philadelphia, Pennsylvania

**TEXAS TECH UNIVERSITY, DEPARTMENT OF MATHEMATICS**  
Lubbock, Texas 79409

**THE TOBACCO INSTITUTE**  
Washington, D.C.

UNION OIL COMPANY OF CALIFORNIA, UNION RESEARCH CENTER  
Brea, California

UNIVERSITY OF ARIZONA, DEPARTMENT OF MATHEMATICS  
Tucson, Arizona

UNIVERSITY OF BRITISH COLUMBIA, DEPARTMENT OF MATHEMATICS  
Vancouver, B.C., Canada

UNIVERSITY OF CALGARY, DIVISION OF STATISTICS, DEPARTMENT OF MATHEMATICS AND STATISTICS  
Calgary, Alberta, Canada

UNIVERSITY OF CALIFORNIA, BERKELEY, STATISTICAL LABORATORY  
Berkeley, California

UNIVERSITY OF CALIFORNIA, DAVIS, DIVISION OF STATISTICS  
Davis, California

UNIVERSITY OF GUELPH, MATHEMATICS AND STATISTICS DEPARTMENT  
Guelph, Ontario, Canada

UNIVERSITY OF ILLINOIS AT CHICAGO CIRCLE, DEPARTMENT OF MATHEMATICS, STATISTICS AND COMPUTER SCIENCE  
Chicago, Illinois

UNIVERSITY OF ILLINOIS, MATHEMATICS DEPARTMENT  
Urbana, Illinois

UNIVERSITY OF IOWA, DIVISION OF MATHEMATICAL SCIENCES  
Iowa City, Iowa

UNIVERSITY OF MANITOBA, DEPARTMENT OF STATISTICS  
Winnipeg, Manitoba, Canada

UNIVERSITY OF MARYLAND, DEPARTMENT OF MATHEMATICS  
College Park, Maryland

UNIVERSITY OF MASSACHUSETTS, DEPARTMENT OF MATHEMATICS AND STATISTICS  
Amherst, Massachusetts

UNIVERSITY OF MICHIGAN, DEPARTMENT OF STATISTICS  
Ann Arbor, Michigan

UNIVERSITY OF MINNESOTA, SCHOOL OF STATISTICS  
Minneapolis, Minnesota

UNIVERSITY OF MISSOURI, DEPARTMENT OF STATISTICS  
Columbia, Missouri

UNIVERSITY OF MISSOURI AT ROLLA, DEPARTMENT OF MATHEMATICS  
Rolla, Missouri

UNIVERSITY OF MONTREAL, DEPARTMENT OF MATHEMATICS  
Montreal, Quebec, Canada

UNIVERSITY OF NEBRASKA, MATHEMATICS AND STATISTICS DEPARTMENT  
Lincoln, Nebraska

UNIVERSITY OF NEW MEXICO, DEPARTMENT OF MATHEMATICS AND STATISTICS  
Albuquerque, New Mexico

UNIVERSITY OF NORTH CAROLINA, DEPARTMENT OF STATISTICS  
Chapel Hill, North Carolina

UNIVERSITY OF OREGON, MATHEMATICS DEPARTMENT  
Eugene, Oregon

UNIVERSITY OF OTTAWA, DEPARTMENT OF MATHEMATICS  
Ottawa, Ontario, Canada

UNIVERSITY OF SOUTH CAROLINA, DEPARTMENT OF MATHEMATICS AND COMPUTER SCIENCE  
Columbia, South Carolina

UNIVERSITY OF TEXAS, DEPARTMENT OF MATHEMATICS  
Austin, Texas

UNIVERSITY OF TEXAS, MATHEMATICS DEPARTMENT  
San Antonio, Texas

UNIVERSITY OF VICTORIA, DEPARTMENT OF MATHEMATICS  
Victoria, British Columbia, Canada

UNIVERSITY OF VIRGINIA, DEPARTMENT OF MATHEMATICS  
Charlottesville, Virginia

UNIVERSITY OF WASHINGTON, DEPARTMENTS OF MATHEMATICS AND STATISTICS  
Seattle, Washington

UNIVERSITY OF WATERLOO, STATISTICS DEPARTMENT  
Waterloo, Ontario, Canada

UNIVERSITY OF WISCONSIN, MILWAUKEE, DEPARTMENT OF MATHEMATICS  
Milwaukee, Wisconsin

VIRGINIA COMMONWEALTH UNIVERSITY, DEPARTMENT OF MATHEMATICAL SCIENCES  
Richmond, Virginia

WAYNE STATE UNIVERSITY, DEPARTMENT OF MATHEMATICS  
Detroit, Michigan

WESTINGHOUSE ELECTRIC CORPORATION, RESEARCH LABORATORIES  
Pittsburgh, Pennsylvania

YORK UNIVERSITY, DEPARTMENT OF MATHEMATICS  
Downsview, Ontario, Canada

# THE ANNALS OF STATISTICS

## INSTRUCTIONS FOR AUTHORS

**Submission of Papers.** Papers to be submitted for publication should be sent to the Editor of the *Annals of Statistics*. (For current address, see the latest issue of the *Annals*.) Four copies should be submitted on paper that will take ink corrections. The manuscript will *not* normally be returned to the author; when expressly requested by the author, one copy of the manuscript will be returned.

**Preparation of Manuscripts.** Manuscripts should be typewritten, entirely double-spaced, including references, with wide margins at sides, top and bottom. All copies must be completely legible. When technical reports are submitted, all extraneous sheets and covers must be removed. Typists should check an issue of the *Annals* for style.

**Submission of Reference Papers.** Four copies of unpublished or not easily available papers cited in the manuscript should be submitted with the manuscript.

**Title.** The title should be descriptive and as concise as is feasible, i.e., it should indicate the topic of the paper as clearly as possible, but every word in it should be pertinent.

**Abbreviated Title.** An abbreviated title to be used as a running head is also required. This should normally not exceed 35 characters. For example, an article with the title "The Curvature of a Statistical Model, with Applications to Large-Sample Likelihood Methods," could have the running head "Curvature of Statistical Model" or possibly "Asymptotics of Likelihood Methods," depending on the emphasis to be conveyed.

**Affiliation.** Indicate your present institutional affiliation as you would like it to appear.

**Summary.** Each manuscript is required to contain a summary, clearly separated from the rest of the paper, which will be printed immediately after the title. Its main purpose is to inform the reader quickly of the nature and results of the paper; it may also be used as an aid in retrieving information. The length of a summary will clearly depend on the length and difficulty of the paper, but in general it should not exceed 150 words. Formulas should be used as sparingly as possible within the summary. The summary should not make reference to results or formulas in the body of the paper—it should be self-contained.

**Footnotes.** Footnotes should not be used, except as described under Title Page Footnotes below. Such information should be included within the text.

**Title Page Footnotes.** Included as a footnote on page 1 should be the headings:

American Mathematical Society 1980 subject classifications. Primary—; Secondary—.  
Key words and phrases.

The classification numbers representing the pri-

mary and secondary subjects of the article may be found with instructions for its use in the *Mathematical Reviews Annual Subject Index-1980*. The key words and phrases should describe the subject matter of the article; generally they should be taken from the body of the paper.

Acknowledgment of support. Grants and contracts should also be included in this footnote.

**Identification of Symbols.** Manuscripts for publication should be clearly prepared to insure that all symbols are properly identified. Distinguish between "oh" and "zero"; "ell" and "one"; "epsilon" and "element of"; "summation" and "capital sigma," etc. Indicate also when special type is required (Greek, German, script, boldface, etc.); unless indicated otherwise, formula letters will be set in italics. Acronyms should be introduced sparingly. Any handwritten symbols should be clearly identified.

**Figures and Tables.** Figures, charts, and diagrams should be prepared in a form suitable for photographic reproduction and should be professionally drawn twice the size they are to be printed. (These need not be submitted until the paper has been accepted for publication.) The printer does not improve upon the quality of the figures submitted. Tables should be typed on separate pages with accompanying footnotes immediately below the table.

**Formulas.** Fractions *in the text* are preferably written with the solidus or negative exponent; thus,

$(a + b)/(c + d)$  is preferred to  $\frac{a + b}{c + d}$ , and  $(2\pi)^{-1}$  or

$1/(2\pi)$  to  $\frac{1}{2\pi}$ . Also,  $a^{b(c)}$  and  $a_{b(c)}$  are preferred to  $a^{b^c}$

and  $a_b$ , respectively. Complicated exponentials should be represented with the symbol exp. A fractional exponent is preferable to a radical sign.

**References.** References should be typed double-spaced and should follow the style:

Kiefer, J. C. (1976). Admissibility of conditional confidence procedures. *Ann. Statist.* 4 836-865.

In textual material, the format "... Kiefer (1976) ..." should be used. Multiple references can be distinguished as "... Kiefer (1976a) ...". Abbreviations for journals should be taken from a current index issue of *Mathematical Reviews*.

**Addresses.** The permanent address of each author should be typed following the references.

**Galley Proofs.** The author will ordinarily receive galley proofs. Corrected galley proofs should be sent to the Managing Editor of the *Annals of Statistics*. (For current address, see the latest issue of the *Annals*.)