

STATISTICAL SCIENCE

a review journal of the institute of mathematical statistics

Volume 9

Number 3

August 1994

STATISTICAL PROBLEMS IN GENETICS AND MOLECULAR BIOLOGY

A Collection of Papers by R. C. Griffiths and Simon Tavaré; W. Navidi and N. Arnheim; David O. Nelson and Terence Speed; E. A. Thompson; and Michael Waterman and Martin Vingron

BOOTSTRAP: MORE THAN A STAB IN THE DARK?

by G. Alastair Young

SOME APPLICATIONS OF NUMBER-THEORETIC METHODS IN MULTIVARIATE STATISTICS

by Kai-Tai Fang, Yuan Wang and P. M. Bentler

EQUIDISTANT LETTER SEQUENCES IN THE BOOK OF GENESIS

by D. Witztum, E. Rips and Y. Rosenberg

and A Conversation with SIR DAVID COX

EXECUTIVE EDITOR

Robert E. Kass
Carnegie Mellon University

EDITORIAL ASSISTANT

Heidi Rhodes

EDITORS

George Casella
Cornell University
Leon Jay Gleser
University of Pittsburgh

Ramanathan Gnanadesikan
Rutgers University
David Griffeath
University of Wisconsin

Terry Speed
University of California, Berkeley
Michael Titterton
University of Glasgow

Nancy Reid
University of Toronto

MANAGING EDITOR

John R. Collins
University of Calgary

PRODUCTION EDITOR

Patrick Kelly

PAST EXECUTIVE EDITORS

Morris H. DeGroot, 1986–1988 Carl N. Morris, 1989–1991

The aim of *Statistical Science* is to present the full range of contemporary statistical thought at a technical level accessible to the broad community of practitioners, teachers, researchers and students of statistics and probability.

The journal will publish discussions of methodological and theoretical topics of current interest and importance, surveys of substantive research areas with promising statistical applications, comprehensive book reviews, discussions of classic articles from the statistical literature and interviews with distinguished statisticians and probabilists.

SUBMISSION POLICY

Statistical Science welcomes the submission of expository, review and survey papers in all areas of the theory, methodology and applications of statistics and probability. Articles that synthesize research that has been published in diverse sources or that has been developed from diverse points of view are especially valuable. Please see the editorial in the February 1992 issue (vol. 7, no. 1) for additional description of the goals of *Statistical Science*.

Authors should submit four nonreturnable copies of any manuscript to be considered for publication in *Statistical Science*. The manuscript should be typed on 8½ × 11-inch white paper, on one side only, and double-spaced throughout, including the references, with margins of at least 1½ inches on all four sides. Pages should be numbered consecutively. The manuscript should contain an abstract of 200 or fewer words, followed by approximately 5 or 6 key words or phrases. A short author's note providing the name, address, present position or rank and affiliation of each author should also be included. Copies should be mailed, first class, to:

Robert E. Kass
Executive Editor, *Statistical Science*
Department of Statistics
Carnegie Mellon University
Pittsburgh, PA 15213-3890

In addition, if possible, a \LaTeX input file should be sent by electronic mail to statsci@stat.cmu.edu. If electronic mail is not feasible, a standard floppy disk may be submitted by first-class mail. Manuscripts submitted in the \LaTeX format should use the "article" style and should not use any special macros.

A condition of submission is that the manuscript has not previously been published and is not simultaneously being considered for publication elsewhere. All authors must transfer copyright to the Institute prior to publication. Page charges are \$45 per printed page. Payment of some or all of the estimated page charges associated with articles is strongly encouraged. The editorial review of articles and administration of page charges are completely separate activities. Manuscripts are reviewed and accepted prior to determining whether page charges will be paid. Corresponding authors receive 25 gratis offprints. Offprints of discussion articles include the main article(s), discussion(s) and rejoinder(s) as a package. Corresponding authors of main articles receive 25 gratis offprints; corresponding discussants receive 10 gratis offprints. Additional offprints may be purchased by using the IMS Offprint Purchase Order Form accompanying the galleys. Copyright transfer, page charges and offprints are the responsibility of the IMS Business Manager.

STATISTICAL SCIENCE

Volume 9, Number 3

August 1994

In This Issue	305
Statistical Problems in Genetics and Molecular Biology	
Ancestral Inference in Population Genetics	<i>R. C. Griffiths and Simon Tavaré</i> 307
Analysis of Genetic Data from the Polymerase Chain Reaction	<i>W. Navidi and N. Arnheim</i> 320
Statistical Issues in Constructing High Resolution Physical Maps	<i>David O. Nelson and Terence P. Speed</i> 334
Monte Carlo Likelihood in Genetic Mapping	<i>E. A. Thompson</i> 355
Sequence Comparison Significance and Poisson Approximation	<i>Michael Waterman and Martin Vingron</i> 367
Bootstrap: More than a Stab in the Dark?.....	<i>G. Alastair Young</i> 382
Comment	<i>Rudolf Beran</i> 395
Comment	<i>B. Efron</i> 396
Comment	<i>Patricia M. Grambsch, Mary Kathryn Cowles and Thomas A. Louis</i> 398
Comment	<i>D. V. Hinkley</i> 400
Comment	<i>Michael P. Meredith and Jorge G. Morel</i> 404
Comment	<i>William Navidi</i> 407
Comment	<i>Mark J. Schervish</i> 408
Rejoinder	<i>G. Alastair Young</i> 411
Some Applications of Number-Theoretic Methods in Multivariate Statistics	<i>Kai-Tai Fang, Yuan Wang and P. M. Bentler</i> 416
Equidistant Letter Sequences in the Book of Genesis	<i>Doron Witztum, Eliyahu Rips and Yoav Rosenberg</i> 429
A Conversation with Sir David Cox.....	<i>Nancy Reid</i> 439
Author's Clarification.....	<i>Kathryn Roeder</i> 456

Statistical Science (ISSN 0883-4237), Volume 9, Number 3, August 1994. Published quarterly by the Institute of Mathematical Statistics, 3401 Investment Boulevard #7, Hayward, California 94545. Second-class postage paid at Hayward, California and at additional mailing offices. **POSTMASTER:** Send address changes to *Statistical Science*, Institute of Mathematical Statistics, 3401 Investment Boulevard #7, Hayward, California 94545-3819.

Copyright © 1994 by the Institute of Mathematical Statistics
Printed in the United States of America

IMS CORPORATE MEMBERS

AT&T BELL LABORATORIES
Murray Hill, New Jersey

BELL COMMUNICATIONS RESEARCH
Morristown, New Jersey

GENERAL MOTORS CORPORATION
Research Laboratories
Warren, Michigan

INTERNATIONAL BUSINESS MACHINES CORP.
Thomas J. Watson Research Center
Yorktown Heights, New York

IMS INSTITUTIONAL MEMBERS

ACADEMIA SINICA
Inst. of Statistical Science
Taipei, Taiwan

AMERICAN UNIVERSITY
Dept. of Mathematics and Statistics
Washington, D.C.

ARIZONA STATE UNIVERSITY
Committee on Statistics
Dept. of Mathematics and Dept.
of Decision and Information Systems
Tempe, Arizona

AUSTRALIAN NATIONAL UNIVERSITY
Canberra, ACT, Australia

BOWLING GREEN STATE UNIVERSITY
Dept. of Mathematics and Statistics
Bowling Green, Ohio

CALIFORNIA STATE UNIVERSITY AT FULLERTON
Dept. of Mathematics
Fullerton, California

CASE WESTERN RESERVE UNIVERSITY
Dept. of Mathematics and Statistics
Cleveland, Ohio

CHINESE UNIVERSITY OF HONG KONG
Statistical Unit
Shantin, Hong Kong

CORNELL UNIVERSITY
Dept. of Mathematics
Ithaca, New York

DALHOUSIE UNIVERSITY
Killam Memorial Library
Halifax, Nova Scotia, Canada

DUKE UNIVERSITY
Mathematics and Physics Library
Durham, North Carolina

FLORIDA STATE UNIVERSITY
Dept. of Statistics
Tallahassee, Florida

GEORGE WASHINGTON UNIVERSITY
Dept. of Statistics
Washington, D.C.

HARVARD UNIVERSITY
Cabot Science Library
Cambridge, Massachusetts

HARVARD UNIVERSITY
Dept. of Biostatistics
Boston, Massachusetts

HARVARD UNIVERSITY
Dept. of Statistics
Cambridge, Massachusetts

INDIANA UNIVERSITY
Dept. of Mathematics
Bloomington, Indiana

INSTITUTE FOR DEFENSE ANALYSIS
Center for Communications Research
La Jolla, California

IOWA STATE UNIVERSITY
Dept. of Statistics and Statistical Laboratory
Ames, Iowa

JOHNS HOPKINS UNIVERSITY
Dept. of Biostatistics and
Dept. of Mathematical Sciences
Baltimore, Maryland

KANSAS STATE UNIVERSITY
Dept. of Statistics
Manhattan, Kansas

MARA INSTITUTE OF TECHNOLOGY
Selangor, Malaysia

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Dept. of Mathematics
Cambridge, Massachusetts

MCGILL UNIVERSITY
Dept. of Mathematics and Statistics
Montreal, Quebec, Canada

MEDICAL COLLEGE OF WISCONSIN
Biostatistics Division
Milwaukee, Wisconsin

MEMORIAL SLOAN-KETTERING CANCER CENTER
Biostatistics Service
New York, New York

MIAMI UNIVERSITY LIBRARY
Oxford, Ohio

MICHIGAN STATE UNIVERSITY
Dept. of Statistics and Probability
East Lansing, Michigan

NATIONAL SECURITY AGENCY
Fort George G. Meade, Maryland

NEW MEXICO STATE UNIVERSITY
Dept. of Mathematical Sciences
Las Cruces, New Mexico

NORTH CAROLINA STATE UNIVERSITY
Dept. of Statistics
Raleigh, North Carolina

NORTH DAKOTA STATE UNIVERSITY LIBRARY
Fargo, North Dakota

NORTHERN ILLINOIS UNIVERSITY
Div. of Statistics
DeKalb, Illinois

OHIO STATE UNIVERSITY
Dept. of Statistics
Columbus, Ohio

OREGON STATE UNIVERSITY
Dept. of Statistics
Corvallis, Oregon

PENNSYLVANIA STATE UNIVERSITY
Dept. of Statistics
University Park, Pennsylvania

PRINCETON UNIVERSITY LIBRARY
Princeton, New Jersey

PURDUE UNIVERSITY LIBRARY
West Lafayette, Indiana

QUEEN'S UNIVERSITY
Dept. of Mathematics and Statistics
Kingston, Ontario, Canada

RICE UNIVERSITY LIBRARY
Houston, Texas

THE ROCKEFELLER UNIVERSITY LIBRARY
New York, New York

SOUTHERN ILLINOIS UNIVERSITY
Dept. of Mathematics and Statistics
Edwardsville, Illinois

STANFORD UNIVERSITY
Dept. of Statistics
Stanford, California

STOCKHOLM UNIVERSITY
Institute of Actuarial Mathematics
and Mathematical Statistics
Stockholm, Sweden

SYRACUSE UNIVERSITY
Dept. of Mathematics
Syracuse, New York

TECHNISCHE UNIVERSITÄT
Inst. für Math Stochastik
Braunschweig, Germany

TEXAS TECH UNIVERSITY
Dept. of Mathematics
Lubbock, Texas

UNIVERSITÄTSBIBLIOTHEK DORTMUND
Bereichsbibliothek Statistik
Dortmund, Germany

UNIVERSITY OF ALBERTA
Dept. of Statistics and Applied Probability
Edmonton, Alberta, Canada

UNIVERSITY OF ARIZONA
Dept. of Mathematics
Tucson, Arizona

UNIVERSITY OF BATH
Library
Bath, United Kingdom

UNIVERSITY OF BRISTOL
Queen's Library
Bristol, United Kingdom

UNIVERSITY OF BRITISH COLUMBIA
Dept. of Statistics
Vancouver, British Columbia, Canada

UNIVERSITY OF CALGARY
Dept. of Mathematics and Statistics
Calgary, Alberta, Canada

UNIVERSITY OF CALIFORNIA, BERKELEY
Dept. of Statistics
Berkeley, California

UNIVERSITY OF CALIFORNIA, DAVIS
Div. of Statistics
Davis, California

UNIVERSITY OF CALIFORNIA, IRVINE
Main Library
Irvine, California

UNIVERSITY OF CONNECTICUT
Dept. of Statistics
Storrs, Connecticut

UNIVERSITY OF FLORIDA
Dept. of Statistics
Gainesville, Florida

UNIVERSITY OF GEORGIA
Dept. of Statistics
Athens, Georgia

UNIVERSITY OF ILLINOIS
Dept. of Statistics
Champaign, Illinois

UNIVERSITY OF ILLINOIS AT CHICAGO
Dept. of Mathematics, Statistics and Computer Science
Chicago, Illinois

UNIVERSITY OF IOWA
Dept. of Statistics and Actuarial Science
Iowa City, Iowa

UNIVERSITY OF MARYLAND
Dept. of Mathematics
College Park, Maryland

UNIVERSITY OF MASSACHUSETTS
Dept. of Mathematics and Statistics
Amherst, Massachusetts

UNIVERSITY OF MINNESOTA
School of Statistics
Minneapolis, Minnesota

UNIVERSITY OF MINNESOTA
Twin Cities Campus Libraries
Minneapolis, Minnesota

UNIVERSITY OF MISSOURI
Ellis Library
Columbia, Missouri

UNIVERSITY OF MONTREAL
Dept. of Mathematics
Montreal, Quebec, Canada

UNIVERSITY OF NEBRASKA
Dept. of Mathematics and Statistics
Lincoln, Nebraska

UNIVERSITY OF NEW BRUNSWICK LIBRARY
Fredericton, New Brunswick, Canada

UNIVERSITY OF NEW MEXICO
Dept. of Mathematics and Statistics
Albuquerque, New Mexico

UNIVERSITY OF NORTH CAROLINA
Dept. of Statistics
Chapel Hill, North Carolina

UNIVERSITY OF OREGON
Dept. of Mathematics
Eugene, Oregon

UNIVERSITY OF PENNSYLVANIA
Dept. of Statistics
Philadelphia, Pennsylvania

UNIVERSITY OF THE PHILIPPINES
AT LOS BAÑOS LIBRARY
Laguna, Philippines

UNIVERSITY OF PITTSBURGH
Mathematics Library
Pittsburgh, Pennsylvania

UNIVERSITY OF SOUTH CAROLINA
Dept. of Statistics
Columbia, South Carolina

UNIVERSITY OF TEXAS AT AUSTIN
Dept. of Mathematics
Austin, Texas

UNIVERSITY OF TEXAS AT DALLAS
Program in Mathematical Sciences
Richardson, Texas

UNIVERSITY OF VICTORIA
Dept. of Mathematics
Victoria, British Columbia, Canada

UNIVERSITY OF VIRGINIA
Dept. of Mathematics
Charlottesville, Virginia

UNIVERSITY OF WASHINGTON
Dept. of Statistics
Seattle, Washington

UNIVERSITY OF WATERLOO
Dept. of Statistics and Actuarial Sciences
Waterloo, Ontario, Canada

US DEPT. OF AGRICULTURE
Forest Service
New Orleans, Louisiana

US DEPT. OF THE AIR FORCE
Air Weather Service Technical Library
Scott AFB, Illinois

VIRGINIA COMMONWEALTH UNIVERSITY
Dept. of Mathematical Sciences
Richmond, Virginia

VIRGINIA POLYTECHNIC INSTITUTE
AND STATE UNIVERSITY
Dept. of Statistics
Blacksburg, Virginia

WAKE FOREST UNIVERSITY
Z. Smith Reynolds Library
Winston-Salem, North Carolina

WAYNE STATE UNIVERSITY
Dept. of Mathematics
Detroit, Michigan

YORK UNIVERSITY
Dept. of Mathematics
Downsview, Ontario, Canada