# STATISTICALI SSENIEL

a review journal of the institute of mathematical statistics

Volume 2

Number 1

February 1987

### **Featuring**

THE CALCULUS OF UNCERTAINTY IN ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

with articles by Glenn Shafer, Dennis V. Lindley, and David J. Spiegelhalter

Joan Fisher Box on GUINNESS, GOSSET, AND FISHER

G W Stewart on

COLLINEARITY AND LEAST SQUARES REGRESSION

An Interview with C. R. RAO

#### **EXECUTIVE EDITOR**

Morris H. DeGroot Carnegie-Mellon University

#### **EDITORIAL ASSISTANT**

Tina Lynne Rees

#### **EDITORS**

David R. Brillinger University of California Berkeley J. A. Hartigan Yale University Ingram Olkin Stanford University

#### MANAGING EDITOR

Paul Shaman University of Pennsylvania

#### **EDITORIAL ASSISTANT**

Tammy Morrow

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.

Four nonreturnable copies of any manuscript submitted for consideration are requested for the reviewing process. Copies should be mailed first class to:

Professor Morris H. DeGroot Executive Editor, Statistical Science Department of Statistics Carnegie-Mellon University Pittsburgh, PA 15213

The manuscripts should be typed on  $8\frac{1}{2} \times 11$ -inch white paper, on one side only, and double-spaced throughout, including the references, with margins of at least  $1\frac{1}{2}$  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.

A condition of submission is that the manuscript has not previously been published and is not simultaneously being considered for publication elsewhere.

Statistical Science is copyrighted and authors will be asked to sign a copyright transfer to the IMS before publication.

## STATISTICAL SCIENCE

Volume 2, Number 1 February	uary 1987	7
In This Issue		1
Probability Judgment in Artificial Intelligence and Expert Systems Glenr		3
The Probability Approach to the Treatment of Uncertainty	, , , , , , , , , , , , , , , , , , , ,	
in Artificial Intelligence and Expert Systems	Lindley 1'	.7
Probabilistic Expert Systems in Medicine: Practical Issues		
in Handling Uncertainty	gelhalter 25	5
Comment Stephen R.	Watson 30	0
Comment	ne Kong 32	2
Comment	n Shafer 3'	7
Comment: A Tale of Two Wells	Lindley 38	8
Comment	gelhalter 40	0:
Rejoinder Glenr	n Shafer 4.	1
Rejoinder	Lindley 42	2
Rejoinder	gelhalter 43	3
Guinness, Gosset, Fisher, and Small Samples Joan Fis	her Box 48	5
A Conversation with C. R. Rao		3
Collinearity and Least Squares Regression	Stewart 68	8
Comment	ırauardt 84	4
Comment: Well-Conditioned Collinearity Indices? David A.	Belsley 86	6
Comment: Diagnosing Near Collinearities in Least Squares Regression	Thisted 91	1
Comment: Diagnosing Near Collinearities in Least Squares Regression		
Ali S. Hadi and Paul F. V	elleman 93	3
Rejoinder	Stewart 98	8
Publications Received	101	1
Acknowledgment of Referees' Services	104	4

Statistical Science (ISSN 0883-4237), Volume 2, Number 1, February 1987. Published in February, May, August, and November 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.

Copyright © 1987 by the Institute of Mathematical Statistics Printed in the United States of America

#### IMS CORPORATE MEMBERS

THE AEROSPACE CORPORATION

Los Angeles, California

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

SPRINGER-VERLAG NEW YORK INCORPORATED

New York, New York

#### IMS INSTITUTIONAL MEMBERS

ACADEMIA SINICA Inst. of Statistics

Taipei, Taiwan

ARIZONA STATE UNIVERSITY

Dept. of Mathematics 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

Depts. of Mathematics and Management Science

Fullerton, California

CASE WESTERN RESERVE UNIVERSITY

Dept. of Mathematics and Statistics

Cleveland, Ohio

CENTERS FOR DISEASE CONTROL

Atlanta, Georgia

CENTRE INTERNATIONAL DE RECONTRE MATH

Marseille, France

CORNELL UNIVERSITY

Dept. of Mathematics

Ithaca, New York

FLORIDA STATE UNIVERSITY

Dept. of Statistics

Tallahassee, Florida

GEORGE WASHINGTON UNIVERSITY

Dept. of Statistics Washington, DC

HARVARD UNIVERSITY

Dept. of Statistics

Cambridge, Massachusetts

Indiana University

Dept. of Mathematics

Bloomington, Indiana

IOWA STATE UNIVERSITY

Dept. of Statistics and Statistical Laboratory

Ames, Iowa

JOHNS HOPKINS UNIVERSITY

Dept. of Biostatistics

Baltimore, Maryland

KANSAS STATE UNIVERSITY

Dept. of Statistics

Manhattan, Kansas

MARA INSTITUTE OF TECHNOLOGY

Selangor, West Malaysia

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Dept. of Mathematics

Cambridge, Massachusetts

MIAMI UNIVERSITY

Dept. of Mathematics and Statistics

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

NORTHWESTERN UNIVERSITY

Dept. of Mathematics

Evanston, 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

Dept. of Mathematical Sciences

Houston, Texas

THE ROCKEFELLER UNIVERSITY LIBRARY

New York, New York

SIMON FRASER UNIVERSITY

Dept. of Mathematics and Statistics

Burnaby, British Columbia, Canada

SOUTHERN ILLINOIS UNIVERSITY

Dept. of Mathematics, Statistics, and Computer Science

Edwardsville, Illinois

SOUTHERN METHODIST UNIVERSITY

Dept. of Statistics

Dallas, Texas

STANFORD UNIVERSITY

Dept. of Statistics Stanford, California

TEMPLE UNIVERSITY Dept. of Mathematics Philadelphia, Pennsylvania

TEXAS TECH UNIVERSITY Dept. of Mathematics . Lubbock, Texas

UNIVERSITY OF ARIZONA Dept. of Mathematics Tucson, Arizona

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

UNIVERSITY OF CALGARY Div. of Statistics Calgary, Alberta, Canada

UNIVERSITY OF CALIFORNIA Dept. of Statistics Berkeley, California

UNIVERSITY OF CALIFORNIA Div. of Statistics Davis, California

UNIVERSITY OF FLORIDA Dept. of Statistics Gainesville, Florida

UNIVERSITY OF GEORGIA Dept. of Statistics Athens, Georgia

UNIVERSITY OF ILLINOIS Dept. of Statistics Urbana, 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 MANITOBA Dept. of Statistics Winnipeg, Manitoba, Canada

UNIVERSITY OF MARYLAND Dept. of Mathematics College Park, Maryland

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

UNIVERSITY OF MICHIGAN Dept. of Statistics Ann Arbor, Michigan

UNIVERSITY OF MINNESOTA School of Statistics Minneapolis, Minnesota

UNIVERSITY OF MISSOURI AT COLUMBIA Dept. of Statistics Columbia, Missouri UNIVERSITY OF MONTREAL Dept. of Mathematics Montreal, Quebec, Canada

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

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 OTTAWA Dept. of Mathematics Ottawa, Ontario, Canada

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

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

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

UNIVERSITY OF TEXAS AT SAN ANTONIO Div. of Mathematics, Computer Science, and Systems Design San Antonio, Texas

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

UNIVERSITY OF VIRGINIA Dept. of Mathematics Charlottesville, Virginia

UNIVERSITY OF WASHINGTON Depts. of Statistics and Mathematics Seattle, Washington

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

UNIVERSITY OF WISCONSIN AT MILWAUKEE Dept. of Mathematical Sciences Milwaukee, Wisconsin

VIRGINIA COMMONWEALTH UNIVERSITY Dept. of Mathematical Sciences Richmond, Virginia

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

WAYNE STATE UNIVERSITY Dept. of Mathematics Detroit, Michigan

YORK UNIVERSITY Dept. of Mathematics Downsview, Ontario, Canada