

AD-A208 680

(2)

## CLASSIFICATION OF THIS PAGE

## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

|                                                                                                                                                                                   |  |                                                                                                   |  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------------------------------------------------------------------------|--|
| 1a. REPORT SECURITY CLASSIFICATION                                                                                                                                                |  | 1b. RESTRICTIVE MARKINGS                                                                          |  |
| 2a. SECURITY CLASSIFICATION AUTHORITY                                                                                                                                             |  | 3. DISTRIBUTION/AVAILABILITY OF REPORT<br>Approved for public release;<br>distribution unlimited. |  |
| 4. CLASSIFICATION/DOWNGRADING SCHEDULE                                                                                                                                            |  | 5. MONITORING ORGANIZATION REPORT NUMBER(S)<br>AFOSR-TR- 89-0740                                  |  |
| 6a. NAME OF PERFORMING ORGANIZATION<br>University of Pittsburgh<br>Department of Mathematics and<br>Statistics                                                                    |  | 6b. OFFICE SYMBOL<br>(If applicable)                                                              |  |
| 7a. NAME OF MONITORING ORGANIZATION<br>AFOSR                                                                                                                                      |  | 7b. ADDRESS (City, State, and ZIP Code)<br>BLDG 410<br>BAFB DC 20332-6448                         |  |
| 8a. NAME OF FUNDING/SPONSORING<br>ORGANIZATION<br>AFOSR                                                                                                                           |  | 8b. OFFICE SYMBOL<br>(If applicable)                                                              |  |
| 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER<br>AFOSR 78-3548                                                                                                                  |  | 10. SOURCE OF FUNDING NUMBERS                                                                     |  |
| 11. TITLE (Include Security Classification)<br>FIFTH INTERNATIONAL SYMPOSIUM ON MULTIVARIATE ANALYSIS                                                                             |  | PROGRAM<br>ELEMENT NO.<br>61102F                                                                  |  |
| 12. PERSONAL AUTHOR(S)<br>P.R. Krishnaiah                                                                                                                                         |  | PROJECT<br>NO.<br>2304                                                                            |  |
| 13a. TYPE OF REPORT<br>Final                                                                                                                                                      |  | TASK<br>NO.<br>A5                                                                                 |  |
| 13b. TIME COVERED<br>FROM _____ TO _____                                                                                                                                          |  | WORK UNIT<br>ACCESSION NO.                                                                        |  |
| 14. DATE OF REPORT (Year, Month, Day)<br>1979                                                                                                                                     |  | 15. PAGE COUNT<br>13                                                                              |  |
| 16. SUPPLEMENTARY NOTATION                                                                                                                                                        |  |                                                                                                   |  |
| 17. COSATI CODES                                                                                                                                                                  |  |                                                                                                   |  |
| 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)                                                                                                 |  |                                                                                                   |  |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number)                                                                                                      |  |                                                                                                   |  |
| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT<br><input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS |  |                                                                                                   |  |
| 21. ABSTRACT SECURITY CLASSIFICATION<br>Unclassified                                                                                                                              |  |                                                                                                   |  |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL                                                                                                                                               |  | 22b. TELEPHONE (Include Area Code)<br>767-5025                                                    |  |
|                                                                                                                                                                                   |  | 22c. OFFICE SYMBOL<br>NM                                                                          |  |

DTIC  
ELECTE  
JUN 07 1989  
S H D

89 6 06 042

(P)

~~AFOSR-IR-89-0740~~  
4F05R-78-3548

REPORT ON

FIFTH INTERNATIONAL SYMPOSIUM ON MULTIVARIATE ANALYSIS

The Fifth International Symposium on Multivariate Analysis was held at the University of Pittsburgh during the period of June 19-24, 1978. This symposium was co-sponsored by the Air Force Office of Scientific Research, Army Research Office, Office of Naval Research and the University of Pittsburgh. Dr. R.A. Smith (Provost, University of Pittsburgh) made the opening remarks. Professor C.R. Rao delivered the Inaugural Address. Many distinguished workers in the world in the area of multivariate analysis participated in the symposium. The Proceedings of the symposium will be published as a bound volume under the title Multivariate Analysis -V by North-Holland Publishing Company in the Fall of 1979. In this volume, distinguished workers in the field from many countries discuss the current developments on a very broad spectrum of topics in the theory and applications of multivariate analysis. The topics covered include classification and pattern recognition, contingency tables, decomposition of multivariate probabilities, design and analysis of experiments, distribution theory, econometric estimation, limit theorems, multivariate analysis of variance, non-parametric methods, optimum properties of test procedures, psychometrics, random matrices, reduction of dimensionality, reliability, scaling methods, simultaneous test procedures, sociometry, statistical physics, stochastic control theory, time series and stochastic processes. This volume will be of great interest to mathematical statisticians, probabilists as well as scientists in other disciplines who use statistical methodology. The symposium gave an opportunity to stimulate interactions between mathematical statisticians, probabilists and data analysts working on different aspects of multi-

— KA —

variate analysis.

The following lists connected with the symposium are attached:

1. Contents of Multivariate Analysis- V
2. List of Chairmen of Sessions
3. List of Contributed Papers
4. List of Presentations in Clinical Sessions



|                    |                                            |
|--------------------|--------------------------------------------|
| Accession For      |                                            |
| NTIS GRA&I         | <input checked="checked" type="checkbox"/> |
| DTIC TAB           | <input type="checkbox"/>                   |
| Unannounced        | <input type="checkbox"/>                   |
| Justification      |                                            |
| By                 |                                            |
| Distribution/      |                                            |
| Availability Codes |                                            |
| Dist               | Avail and/or Special                       |
| A-1                |                                            |

## CONTENTS OF MULTIVARIATE ANALYSIS-V

Editor's Preface

### PART I: REDUCTION OF DIMENSIONALITY AND ESTIMATION

C. Radhakrishna Rao: Matrix Approximations and Reduction of Dimensionality in Multivariate Statistical Analysis\*

T. W. Anderson: Recent Results on the Estimation of a Linear Functional Relationship

A. P. Dempster, Nan Laird and Donald B. Rubin: Iteratively Reweighted Least Squares for Linear Regression When Errors are Normal/Independent Distributed

L. P. Devroye and T. J. Wagner: The Strong Uniform Consistency of Kernel Density Estimates

J. Kiefer: Designs for Extrapolation When Bias is Present

### PART II: TIME SERIES AND STOCHASTIC PROCESSES

A. V. Balakrishnan: Non-Linear White Noise Theory

Takeyuki Hida: Causal Analysis in Terms of Brownian Motion

D. A. Dawson: An Infinite Geostochastic System

G. Kallianpur: A Stochastic Equation for the Conditional Density in a Filtering Problem

P. A. W. Lewis: Simple Models for Positive-Valued and Discrete-Valued Time Series With ARMA Correlation Structure

A. G. Miané and H. Salehi: On the Prediction of Periodically Correlated Stochastic Processes

Emanuel Parzen and H. J. Newton: Multiple Time Series Modeling II

\*Inaugural address.

PART III: LIMIT THEOREMS AND NONPARAMETRIC METHODS

Harald Bergström: On Arrangements Which Determine Limit Theorems for Eigenvalues of a Sample Covariance Matrix

J. R. Blum and V. Susarla: Maximal Deviation Theory of Density and Failure Rate Function Estimates Based on Censored Data

Marie Hušková: Some Asymptotic Results on the Multivariate Rank Statistics

M. Rosenblatt: Some Limit Theorems for Partial Sums of Stationary Sequences

S. Watanabe: A Limit Theorem for Sums of I.I.D. Random Variables With Slowly Varying Tail Probability

PART IV: CHARACTERISTIC FUNCTIONS, DISTRIBUTION THEORY AND RANDOM MATRICES

Mark J. Christensen and A. T. Bharucha-Reid: Companion Matrices Associated With Random Algebraic Polynomials

Roger Cuppens: Recent Results on the Decomposition of Multivariate Probabilities

A. W. Davis: Invariant Polynomials With Two Matrix Arguments Extending the Zonal Polynomials

R. H. Farrell: Calculation of Complex Zonal Polynomials

B. Gyires: On a Characterization of the Generalized Multinomial Distributions

A. M. Mathai and P. N. Rathie: On the Non-Null Distribution of a Test Criterion for Testing Equality of Populations

M. S. Srivastava and E. M. Carter: Asymptotic Expansions for Hypergeometric Functions

J. Tiago de Oliveira: Bivariate Extremes: Foundations and Statistics

PART V: TESTS OF HYPOTHESES AND CLASSIFICATION

D. A. S. Fraser and Kai W. Ng: Multivariate Regression:  
Analysis With Spherical Error

Seymour Geisser: Sample Reuse Selection and Allocation Criteria

A. T. James and W. Venables: Interval Estimates for a Bivariate  
Principal Axis

Michael D. Perlman: Unbiasedness of Multivariate Tests: Recent  
Results

PART VI: SIMULTANEOUS TEST PROCEDURES

C. M. Cox, P. R. Krishnaiah, J. C. Lee, J. Reising and F. J. Schuurman:  
A Study of Finite Intersection Tests for Multiple Comparisons of Means

Govind S. Mudholkar and Perla Subbaiah: MANOVA Multiple Comparisons  
Associated With Finite Intersection Tests

Robert A. Wijsman: Smallest Simultaneous Confidence Sets With  
Applications in Multivariate Analysis

PART VII: APPLICATIONS

Jan de Leeuw and William Heiser: Multidimensional Scaling With  
Restrictions on the Configuration

Emad El-Newehi and Frank Proschan: Multistate Reliability Models:  
A Survey

Stephen E. Fienberg and Richard R. Picard: Designing Surveys for  
Measuring Change in Categorical Data Structures Over Time

K. S. Fu: Stochastic Tree Languages and Their Applications to  
Picture Processing

S. James Press: Multivariate Group Judgments by Qualitative  
Controlled Feedback

Keith F. Ratcliff: Level Spacing Distributions for Electrons  
Confined by Irregular Surfaces

Fumiko Samejima: Latent Trait Theory and its Applications

Henri Theil and Kenneth Laitinen: Singular Moment Matrices  
in Applied Econometrics

Oliver C. S. Tzeng, Charles E. Osgood and William H. May:  
Toward Universal Macro-Denotative Meaning Systems via a  
Cross-Cultural Multivariate Quantification Procedure

LIST OF CONTRIBUTED PAPERS

LIST OF PRESENTATIONS IN CLINICAL SESSIONS

# LIST OF CONTRIBUTED PAPERS

- K. ALAM and J.S. HAWKES (Clemson University): Minimax  
Property of Stein's Estimator with Respect to Non-  
Quadratic Loss.
- M.M. ALI, N.N. MIKHAIL and M.S. HAQ (University of Western  
Ontario, Canada): A Class of Bivariate Distributions  
Including the Bivariate Logistic.
- J.A. ANDERSON (University of Newcastle Upon Tyne, United  
Kingdom): Multivariate Logistic Compounds.
- R.F. ANDERSON and W.E. WINKLER (University of Pittsburgh):  
On Optimal Estimation in a Poisson Cost Problem.
- R. ATKIN (Carnegie-Mellon University): An Analysis of Career  
Salary Progression.
- B. BALDESSARI (University of Rome, Italy): On Some Measure of  
Concordance.
- A.P. BASU (University of Missouri-Columbia) and J.K. GHOSH  
(Indian Statistical Institute, India): Identifying of the  
Multinomial and Other Distributions Under Competing Risk  
Model.
- H.W. BLOCK and T.W. SAVITS (University of Pittsburgh):  
Multivariate IFRA Distributions.
- W.F. CASELTON and T. HUSAIN (University of British Columbia,  
Canada): Multivariate Continuous Distributions and  
Hydrologic Networks.

## LIST OF CONTRIBUTED PAPERS

- H.J. CHEN (University of Georgia): Interval Estimation for the Largest Component Mean for Multivariate Normal Distribution.
- M.J. CLEARY (Wright State University): Application of Regression to a Machine Shop Problem.
- F. CRITCHLEY (University of Glasgow, United Kingdom): Multidimensional Scaling--a Short Critique and a New Method.
- H.L. CRUTCHER (University of North Carolina at Asheville) and L.M. FALLS (University of Alabama): Testing for Multivariate Normality.
- J. DELANEY and A.S. PAULSON (Rensselaer Polytechnic Institute): Robust Estimation of Mean Vector and Covariance Matrix of the Multivariate Normal Distribution.
- P.D. DOREIAN and N.P. HUMMON (University of Pittsburgh): On Providing Estimates for Differential Equation Models of Social Phenomena: An Essay on the Mathematical Study of Change.
- W. GERSCH (University of Hawaii): Discrimination in Stationary Gaussian and Non-Gaussian Time Series by Kullback-Leibler Number Rules.
- R.D. GUPTA and D. RICHARDS (University of West Indies, Jamaica): Calculation of Zonal Polynomials of  $3 \times 3$  Positive Definite Symmetric Matrices.

LIST OF CONTRIBUTED PAPERS

- H.L. HARTER (Air Force Flight Dynamics Laboratory): Some Early Applications of Order Statistics to Multivariate Analysis.
- S.T. HUANG (University of Cincinnati): On the Representation of Nonlinear Systems with Gaussian Inputs.
- A. KAPTEYN, T. WANSBEEK and J. BUYZE (Leiden University, The Netherlands): Errors in Variables: Consistent Adjusted Least Squares (CALS) Estimation.
- D. KAZAKOS (State University of New York at Buffalo) and T. PAPANTONI-KAZAKOS (Bell Laboratories and Rice University): Asymptotic Discrimination Between Stationary Gaussian Processes.
- R. KULPERGER (Carleton University, Canada): Inference for a Simple Branching Diffusion Process.
- J.C. LEE (Wright State University and Air Force Flight Dynamics Laboratory): A Review of Computations of Multivariate Distributions done at the Aerospace Research Laboratories.
- L.C. MARSH and S.S. MODAK (Notre Dame University): Testing General Linear Multiple Mixtures of Equality and Inequality Restrictions with Applications to Regression Analysis.
- M. MAZUMDAR (Westinghouse Research and Development Center): An Optimum Component Testing Procedure for a Series-Parallel System.

LIST OF CONTRIBUTED PAPERS

- G.V.L. NARASIMHAM (United States Department of Commerce):  
Multiple Time Series Models for Forecasting Economic  
Time Series.
- A. RUKHIN (Purdue University): Universal Estimation in the  
Multivariate Analysis.
- S. SCLOVE (University of Illinois at Chicago Circle): Testing  
Independence of Variates in an Infinitely Divisible Random  
Vector, with Applications to Stochastic Processes.
- T. SEIDENFELD (University of Pittsburgh): A Reconstruction of  
Fisher's Fiducial Argument.
- G.A. SHEA (University of Texas at Austin): Linear Discrimina-  
tion and Canonical Factor Analysis.
- R.S. SINGH (University of Guelph, Canada): Speed of Convergence  
in Nonparametric Estimation of Mixed Partial Derivatives of  
a Multivariate Density.
- W. SMOCK (Wayne State University): Multivariate Model for  
Child Care.
- F.E. SYMONS and P.L. DARIUS (Katholieke Universiteit, Leuven,  
Belgium): A Comparison of  $\det(W)$ ,  $\text{tr}(W)$  and  $\text{tr}(W^{-1}B)$  as  
Criterion-Functions in Cluster Analysis.
- J. TAMA (Bell Telephone Laboratories) and D.F. MORRISON  
(University of Pennsylvania): An Error Rate Criterion for  
Step-Wise Linear Discriminant Analysis.

# LIST OF CONTRIBUTED PAPERS

- S.B. TAN (University of Pittsburgh): Maximum Likelihood Estimation for an Autoregressive Process with Missing Observations.
- D.S. TRACY (University of Windsor, Canada): Estimation of Multivariate Moments of Finite Populations.
- C.T. TU and C.P. HAN (Iowa State University): Discriminant Analysis Based on Binary and Continuous Variables.
- D. TYLER (University of Pittsburgh): Asymptotic Inference for Eigenvectors.
- G.W. WALSTER (University of Wisconsin) and M.J. TRETTER (Pennsylvania State University): Exact Noncentral Distribution of Wilks' A and Wilks-Lawley U Criteria as Mixtures of Incomplete Beta Functions: For Three Tests.
- T. WANSBEEK and A. KAPTEYN (Leiden University, The Netherlands) A General Analysis of Covariance Structures of Longitudinal Data.
- S.J. WOLFE (University of Delaware): On the Unimodality of Multivariate Infinitely Divisible Distribution Functions.
- W.A. WOYCZYNSKI (Cleveland State University): Central Limit Theorems vs. Geometric Structures in Banach Spaces.
- H. YANAI (Chiba University, Japan): Invariance Property of Canonical Correlation Analysis and its Applications.
- H. YASSAEE (Arya-Mehr University of Technology, Iran): On Analysis of Multidimensional Contingency Tables: Multiple Linear Logit Model.
- S. ZACKS (Case Western University): Simultaneous Estimation of Interaction Parameters in  $2 \times k$  Binomial Experiments.

LIST OF PRESENTATIONS IN CLINICAL SESSIONS

N. COBEAN (Army Natick Research and Development Command):

The Analysis of Response Data in Army Mess Hall  
Preference.

H.L. CRUTCHER (University of North Carolina at Asheville):

Some Unsolved Meteorological Multivariate Problems.

S. DUBEY (Food and Drug Administration): Some Multivariate

Statistical Problems in Research on Drugs.

G.T. DUNCAN (Carnegie-Mellon University): Elicitation for

Dirichlet-Multinomial Sampling.

I.I. GRINGORTEN (Air Force Geophysics Laboratory): Conditional

Probabilities of Ceilings and Visibilities at a Point,  
Along a Line, and in an Area.

J.E. MICHALEK (Air Force School of Aerospace Medicine): The

West Point Follow-Up Study.

M.G. YOCHMOWITZ (USAF School of Aerospace Medicine): Analysis

of Primate Flight Simulator Data.

LIST OF CHAIRMEN OF SESSIONS

R.R. Bahadur

A.P. Basu

W.W. Cooley

S. Das Gupta

M. Dutta

S. Geisser

A.K. Gupta

S.S. Gupta

H.L. Harter

T. Jayachandran

G. Kallianpur

L. Kanal

S. Kotz

R.L. Launer

J.C. Lee

R.L. Lundergard

P. Masani

A.M. Mathai

R.J. Muirhead

L.D. Pitt

B.R. Rao

J. Reising

A. Rukhin

F.J. Schuurman

P. Subbaiah

N.H. Timm

V.B. Waikar

S. Watanabe

S.J. Wolfe

S. Zacks