STATISTICAL
LABORATORY

Contents

THE STATISTICAL LABORATORY
Iowa State University
1977-78 Annual Report

Personnel

Iowa State University's Statistical Center is directed by H. A. David. The Center consists of the Statistical Laboratory, an Institute under the president's office, the Department of Statistics in the College of Sciences and Humanities, the Statistics Department in the Agriculture and Home Economics Experiment Station, and the statistics participants in the Sciences and Humanities and Engineering Research Institutes. Many faculty members have duties in more than one of the Center's components.

The following faculty promotions were approved for fiscal year 1978-79: Paul Hinz, William J. Kennedy, Glen D. Meeden, and Vincent A. Sposito from associate professors to professors; Theodore B. Bailey, Jr., James E. Gentle, and William Q. Meeker, Jr. from assistant professors to associate professors. Effective July 1, 1978, Gordon Booth became associate professor-collaborator.

Malay Ghosh, earlier a visiting faculty member, rejoined the Department as Professor on March 1. He was recently elected a Fellow of the Institute of Mathematical Statistics.

Dr. Craig Van Nostrand enjoyed good company and haute cuisine at the annual spring breakfast.

Dr. Kenneth Koehler joined the staff this year as an assistant professor. Statistical methods and sparse contingency tables are his fields of interest.

Dr. William G. Hill, a reader in genetics at the University of Edinburgh, returned to the Department as a visiting professor from June 26-August 10. During the summers of 1967, 1969, 1970, and 1972, Hill was a visiting research associate with the Department. Hill has held various consulting appointments in the animal breeding industry. He conducted research supported by Dr. Pollak's grant in mathematical and statistical genetics.

Don Hotchkiss was selected as the Outstanding Advisor in the College of Agriculture for 1977-78. Hotchkiss is the advisor for the biometry program in agriculture and is also heavily involved in advising in the College of Sciences and Humanities.

Oscar Kempthorne was a visiting professor of statistics at Florida State University in Tallahassee during the winter quarter of 1978. He taught a course on the design of experiments. In collaboration with Professor D. Basu, Kempthorne gave a course on "Controversies in Foundations of Statistics."

Dr. Lynn R. LaMotte, Department of Quantitative Management Science, University of Houston, was visiting associate professor in the Department of Statistics from June 1-July 31, 1978. During his visit, he pursued research on linear statistical models in conjunction with Dr. David Harville.

Craig Van Nostrand, currently temporary assistant professor, will have a regular appointment as assistant professor beginning July 1. He will fill the vacancy created by the resignation of Richard Mensing.

Barton A. Bixenstine has resigned from his appointment as assistant professor of political science and statistics in order to attend law school.

Statistical Laboratory Staff — Fiscal Year 1977-78 under the administrative direction of:

W. Robert Parks, Ph.D — President of the University

Daniel J. Zaffarano, Ph.D. — Vice President for Research; Dean of the Graduate College

Wallace A. Russell, Ph.D. — Dean, College of Sciences and Humanities

Lee R. Kolmer, Ph.D. — Dean, College of Agriculture; Director, Iowa Agriculture and Home Economics Experiment Station

Herbert A. David, Ph.D. — Director, Statistical Laboratory; Head, Department of Statistics; Head, Statistics Department, Iowa Agriculture and Home Economics Experiment Station

Professors

Barry C. Arnold, joint appointment with Department of Mathematics

T. A. Bancroft, Professor Emeritus

C. Philip Cox

David F. Cox

Herbert A. David

Herbert T. David, joint appointment with Department of Industrial Engineering

Wayne A. Fuller, faculty status in Economics as well as Statistics

Malay Ghosh, beginning March 1

Richard Groeneveld

Chien-Pai Han

David A. Harville

Roy D. Hickman

Donald K. Hotchkiss

David V. Huntsberger

Dean Isaacson, joint appointment with Department of Mathematics

Oscar Kempthorne, Distinguished Professor, College of Sciences and Humanities

Edward Pollak, joint appointment with Department of Genetics

Robert F. Strahan, joint appointment with Department of Psychology

Norman Strand, Professor Emeritus

B. V. Sukhatme

Richard D. Warren, joint appointment with Department of Psychology

W. J. Conover, visiting, summer 1977

William G. Hill, visiting, summer, 1978

William F. Taylor, Collaborator, in residence at Mayo Clinic

Associate Professors

Paul Hinz, on leave from September 1 at Oregon State Univeristy

William J. Kennedy

Glen Meeden

Vincent A. Sposito, joint appointment with Computation Center

Lynn R. LaMotte, visiting, summer, 1978

Assistant Professors

Theodore B. Bailey, Jr.

Harold D. Baker

Barton A. Bixenstine, joint appointment with Department of Political Science

James E. Gentle

J. Jeffrey Goebel

William Q. Meeker, Jr.

Shashikala Sukhatme

Gordon Booth, USDA Collaborator

Peter C. O'Brien, Collaborator, in residence at Mayo Clinic

Adjunct Assistant Professor

Tom Bubolz

Instructors and Associates

Kim Andriano

Richard Dorsch

Graduate Assistants

The status of graduate students often changes. Students who have held regular appointments as graduate assistants during the year are listed here.

Auer, Richard

Bhattacharyay, Biswanath

Biyani, Shriram

Castonguay, Joy

Chandhok, Promod Kumar

Chang, Shen-Lan Chu

Chavez-Guerrero, Shirley

Chen, Jengrong James

Dahm, P. Fred

David, Jeffrey

Der, William

Escobar, Luis Alberto

Ferree, Rita

Guerrero, Margarita

Hale, Michael Don

Hand, Michael L.

Hasza, David P.

Ho, Chung Man

Hong, Emile

Huang, Michael

Ihnen, Leigh

Jan, Yih-Ming

Johnson, Steven

Kackar, Raghu Nath

Kaluzny, Stephen

Kim, Geung Ho

Kivior, Susan

Lee, Edward Henry

Lewis, Jerry

Lin, Cherng-Tarng

Londhe, Anil

Mee, Robert

Mei, Maria

Midha, Chand

Motoyama, Tetsuro

Mowers, Ron

Mowrey, Daniel

Nagaraja, H. N.

Noma, Akihiro

Penner, Don

Ponder, Wendell

Prebihalo, John

Protz, Steven

Rangachari, Lakshmi

Razmpour, Ahmad

Richards, Winston A.

Sallas, William M.

Scott, Mark

Sedcole, Richard

Shen, Arn-Shi

Shenk, Debra

Shu, Ven-Shion

Skalland, Kent

Skarpness, Bradley

Stewart, John

Tan, Hsien-Hui

Tu, Ching-Tsao

Werner, Neil

Wu, Amy Tei-Mei

Yergler, Dennis K.

Yih, Wei

Yu, Fu-Hau

Supported Graduate Students

Aain, Sukor — MARA, Malaysia
Abdel-Megeed, Samir — American Friends of the Middle East (AFME)
Al-Fozan, Abdulrahman — Saudi Government
Anselmi, Luis — Institute of International Education
Aziz, Mohammad — Ag. Development Council Fellowship
Carvalho, Jose' — University of Sao Paulo, Brazil
Chen, Jiunn-Charn — Ministry of National Defense
Chiyenda, Simeon S. — Agency for International Development (AID)
Crouse, Ken — Ames Lab, ISU
DaSilva, Antonio — CAPES (an agency of the Brazilian Ministry of Education and Culture)
Dehghan-Nayeri, Majid — Department of Mathematics, ISU
Ebrahimi, Nader — MEE, Iranian Government
Egbon, Michael — Benin Area Joint Board
Esmail, Habib — AMIDEAST
Fakiya, James O. — Ondo-State Government Post-Graduate Scholarship
Galmes, Miguel — Food and Agriculture Organization (FAO)
Herrera-Haro, Jose' — Nat. Council of Sci. and Tech. and Ford Foundation
Huang, Cheng-Chi — Department of Mathematics
Laidig, Friedrich — DAAD (Deutscher Akademischer Austauschdienst)
Lamyordmakpol, Anuchit — Government of Thailand
Liberty, T. Edward — USAID
Lo-Utai, Sue — Government of Thailand
Megahed, Abdel Razek — Egyptian Government
Mo, Wing-Hung David — Department of Industrial Engineering, ISU
Niknian, Minoo — AFME
Nkansah, Paul — Department of Mathematics, ISU
Noorbaloochi, Siamak — Iranian Government
Osho, Johnson — Nigerian Government
Palmer, Joan — U.S. Department of Commerce
Parsian, Ahmad — Department of Mathematics, ISU
Peixoto, Julio — AID
Pongsrihadulchai, Apichart — USAID
Ridpath, Harold — Department of Mathematics, ISU
Saad-Eldin, Mohamed — University of Gezira
Sakia, Remi — Ford Foundation
Sastrosowignjo, Soetarto — MUCIA
Sivira, Jose' — University of Los Andes, Venezuela
Slamet — Sub. Inst. of Tech. Proj. — ADB
Stangenhaus, Gabriela — University of Sao Paulo, Brazil
Sung, Bok Park — Department of Mathematics, ISU
Sung, Chang-Sup — Department of Industrial Engineering, ISU
You, Young-Kyun — Korean Government
Zaher, Adel — AFME

Self-Supporting Graduate Students

Bondy, Eric
Caravavattana, Rattana

Hsu, Sheue-Wen
Kuo, Tsuey Lin
Mellon, James
Seyedsadr, Seyed Mahmoud
Simon, Barry
Yen, Shu-Mien

Survey Section

Caroll Arthur, Statistical Data Processor
Glenda Love Ashley, Key Punch Operator
Leilani Bassett, Key Punch Operator
Carol Charlson, Statistical Clerk
Hazel Cook, Survey Supervisor
Margaret Fowler, Statistical Clerk
Mary A. Genalo, Statistical Clerk
Evelyn Green, Survey Supervisor
Sylvia Larson, Statistical Clerk
Marion Martin, Statistical Data Processor
Marjorie Mason, Survey Supervisor
Sylvia McNulty, Bookkeeper
Helen Nelson, Secretary
Margaret Nichols, Secretary
Donna Omundson, Statistical Clerk
Florence Osam, Statistical Clerk
Jeanne Sorenson-Wright, Statistical Clerk
Randy Tanaka, Programmer
Harvey Terpstra, Junior System Analyst
Joanne Wagner, Statistical Data Processor
Elaine Widmann, Key Punch Operator
Margaret Whitehill, Photo Technician to June 6, 1978

Statistical Data Processing Service

Bud J. Meador, Supervisor
Heitsu Chou (Helen) Tu, Junior Data Analyst, through June 12, 1978

General Office Staff

Avonelle Jacobson, Administrative Assistant
Betty Ibrahim, Accountant
Kathleen Shaver, Information Specialist (through November)
Nancy J. Barry, Information Specialist (beginning January 4)
Cheryl Balko, Secretary
Phyllis Carr, Secretary — Experimental Design Genetic Statistics Section
Norma Elwick, Secretary
Valerie Engeltjes, Secretary — Statistical Numerical Analysis and Data Processing Section, beginning October 25
Suzanne Kay Hull, Secretary
Donna Muell, Secretary, ending October 31
Sandy Howard, Secretary
Marylou Nelson, Secretary, beginning September 3
Janice Peters, Secretary, beginning October 3
Dallis Sonksen, Secretary, through August 10

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Consulting and Cooperative Research

A function of the Statistical Laboratory is to provide consulting services to Iowa State University students and faculty who request assistance with research design, data collection, or data analysis and interpretation. A variety of contracts and arrangements enable consultants and supporting staff to serve off-campus agencies.

All faculty members and some graduate research assistants are available for consulting but some are budgeted primarily in this area. A consulting room staffed by graduate assistants from the Statistical Numerical Analysis and Data Processing Section opened last year and has continued to serve Iowa State researchers on a "walk in" basis concerning problems encountered with computer use.

Statistical Laboratory consultants continually modify existing statistical procedures, develop new techniques, and add new equipment to enable them to keep abreast in their field and provide the highest quality consulting services.

Examples of this year's consulting follow.

Social Sciences

Richard Warren, joint appointment with sociology and anthropology, served as a consultant for the research studies of 30 faculty members and 60 graduate students with interests in sociology, family environment, economics, and education. His assistance was sought at various stages in their research ranging from data collection techniques and research designs to interpretation of the statistical analysis and resulting inferences. There was considerable variation in the complexity of the statistical analysis, subject matter involved, and degree of involvement by the consultant.

Several consulting requests involved the measurement of variables and statistical procedures when the variables had measurement errors. Activities included developing questions and observational techniques to obtain the necessary data; coding and scoring the responses to items; construction of scales, indexes, or composite measures; and assessment of measures in terms of validity and reliability including estimation of reliability or measurement error. Several regression analyses were completed using the errors-in-variables approach available through the Super Carp program developed by Michael A. Hidiroglou, Wayne Fuller, and Roy Hickman.

Another major area of consulting requests involved statistical procedures and interpretation for causal analysis in non-experimental research settings. Major consulting topics were path analysis procedures, ratio variables in path analysis, and use of multiple indicator approaches.

Some of the topic areas on which Dr. Warren was consulted include: rural cooperatives in less developed countries, employee information and job satisfaction, factors influencing female adult students to continue their education, adoption of school reorganization by school districts, attitude toward parental involvement of speech-language pathologists, farmers' adoption of agricultural technology in less developed countries, family expenditures for transportation, achievement scores of students, student satisfaction, regression approaches for forecasting economic trends, inservice activities of teachers, role expectations by age and sex, perception of power and authority in formal organizations, factors related to marital happiness, life cycles of families, factors related to academic achievement, factors related to organizational effectiveness of businesses, and organizational effectiveness in formal organizations, evaluation of alternative teaching methods and programs, and perceptions of student personnel services.

During the year, Dr. Warren served on advisory committees for 19 M.S. students completing their degrees with creative components or theses, and 18 Ph.D. students completing their degrees.

Leroy Wolins, joint appointment with psychology, consulted primarily with the child development department. He assisted in the development of questionnaires to be used by both parents in evaluating their children's behavior. One study involved behavioral descriptions of over 100 observational units, where a unit was defined by the child but responses were obtained from both parents and the child's teacher as well as the child. Other projects for which Wolins consulted were developing a scale for measuring preferences for cooperative *versus* competitive behavior in children; assessing the impact of closely or widely spaced age differences among siblings in determining cognitive development; and determining if objective measures of creativity are related to the judged behavior of children in structured play situations.

Engineering Research Institute

Professors H. T. David and Craig Van Nostrand carried out much of the ERI-sponsored consulting, together with Neil Werner, who continued in the second year of his consulting assistantship in the Engineering Research Institute.

Substantial time was spent assisting Nuclear Engineering staff members in the proposal and initial research stages of a contract with the Nuclear Regulating Commission (NRC). This contract involved a variety of statistical problems, including the construction of a code for classifying nuclear plant operator errors, the modeling, analysis, and prediction of such errors, and the design of related simulation experiments and operator surveys.

Another major effort was in conjunction with a project in Industrial Engineering devoted to updating the "Iowa Curve System" for the life analysis of industrial properties.

Examples of other projects for this year follow:

Architectural Engineering: Professors C. Van Nostrand and C. Saccopoulous received funds from the Design Center to develop a program designed to simulate passenger flow (immigration, baggage, and customs) in an airport. The program will be used to help design airport facilities and plan personnel requirements.

Chemical Engineering: Two multifactor experiments investigating the shrinking core model in coal desulphurization and the removal of sulphur as a function of acidity and oxygen level were analyzed. Standard ANOVA techniques were applied to data to give a concise explanation of both sets of data.

Civil Engineering: An extensive research project was conducted to investigate the effects of flow rate, filter length, and sand size on the ability of a filter to remove various sized particles from water.

Another study investigated the effect of additives on the efficiency of a nearby sewage treatment plant. Data on ambient temperature, rainfall, and other factors known to affect sewage treatment efficiency were collected for several months. Analyses were performed to make a more meaningful comparison between the effects of additives and those of non-additives.

Carol Becker, Professor Porter, and ERI consultants compared several models which had been proposed to explain the strength of corrugated steel reinforced concrete in the presence of many uncontrolled variables.

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An agricultural engineer inquired about model adequacy when trying to predict pressure from flow and density within a column of grain. He was also interested in the input of some standard statistical programs.

A chemist was assisted with the design and analysis of a non-linear experiment involving oscillations in crystals.

R. C. Sanderson sought assistance in interpreting the results of a Monte Carlo solution of a partial differential equation.

A mechanical engineer was helped with the analysis of the random surface of a metal sheet.

Many other people received service which could usually be handled in brief consultations. The following is a short list of such people:

Name	Department	Problem
T. Demirel	Civil Engineering	Testing statistical hypotheses
D. Dowell and M. Hammers	Chemical Engineering	Outliers
D. Harrington	Industrial Administration	Bayesian estimation

Agriculture and Home Economics Experiment Station

Statistical consulting on research in the Agriculture Experiment Station continues to grow as more individual jobs were handled last year than ever before. The work flows from all areas of the Experiment Station and grows not only in volume but in complexity as the scientific capability to measure more and more variables in intricate biological experimentation continues to advance.

The exploratory tools of cluster analysis continue to aid in many investigations. Debra Shenk and Dan Mowrey provided cluster analyses for research in animal ecology, agronomy, and animal science. Shenk also attended the meetings of the Classification Society in South Carolina where clustering was the main topic.

Mike Hale provided continuing consulting support for work in swine diseases, especially those related to mastitis. Hale also handles several problems arising from studies in bacteriology where different culturing media and sources of samples were being compared.

The ecological inter-relationships of elk and other mammals with a large park range were studied using extensive and diverse data collected over several seasons. Kim Andriano has been handling this continuing project which requires considerable data handling and computing. The more standard studies conducted in the fields and laboratories of agronomy, horticulture, and botany and plant pathology flow through this unit on a regular basis. None are routine and all require some special attention to some particular aspect. The work from animal physiology, nutrition, and genetics also continues to provide challenges to existing techniques of design and analysis.

Mike Hand has considerable background in computing and handling large data sets and so is sought by many researchers whose work involves such problems. Hand has given major support to ecological studies involving birds and small mammals in Iowa.

While the analysis of biological assays can, in many situations, be labeled routine, the studies that find their way to this unit are seldom straightforward. Dan Mowrey has developed an expertise in this area and assists research workers,

especially those in reproductive physiology, with various types of bioassay.

The unit greatly appreciated the visits of Drs. Cochran and Tukey during the last year. Their lectures and comments were stimulating and very helpful for people engaged in daily statistical consulting.

Statistical Numerical Analysis and Data Processing Section

This section of the Statistical Laboratory is responsible for providing consulting and operational support for educational and research applications of digital computers. A large part of the work done by members of the section can be called "Statistical Computing" under a usual definition of the term.

The workload in consulting on the use of scientific software systems was especially heavy during this past year. Several factors contributed to this increased activity. The most notable are the greater frequency of appearance of new versions of the various systems, significant extension in program capabilities, and a larger population of users. Dr. Bubolz supervised the section maintenance and installation activities relative to supporting software systems. New versions of SAS, SPSS, BMDP, and the IMSL Library were installed and tested by section personnel working in cooperation with systems analysts in the Computation Center.

Programming and data processing support for a wide variety of projects was provided by section personnel during the year. A few of the projects, and the section members who were involved with them, are as follows.

A continuing project for the Iowa Association of School Boards was supported by Fred Ho and Akihiro Noma under the supervision of Dr. Bubolz. The final version of a large annual report generating program was delivered during the year. A computer based system for managing the teacher contract negotiation data base was also completed, and work has begun on a program for analysis of contract characteristics and their relationship to attributes of teacher/administrator negotiators.

Another continuing project is in support of the Ames Lab-ERDA study of trace element composition of terrestrial and aquatic plants adjacent to coal-fired power plant sites in southwestern Montana. Considerable programming effort has been devoted to the development of special analysis capabilities for the large data set produced thus far. Emile Hong, Akihiro Noma, Fred Ho, and Dr. Bubolz are providing section support for this project.

Programming, data processing, and data analysis support was provided to the Iowa State Conservation Commission on the annual deer and small game harvest surveys. Section personnel also assist-

ed in the creation of a historical-type data base consisting of samples of pheasant population in each of the 99 Iowa counties taken on a semi-annual basis over the past several years. Bradley Skarpness, Fred Ho, and Akihiro Noma were involved in this project, with Dr. Bubolz providing general supervision.

Bradley Skarpness also worked on the design and implementation of an interactive data storage, retrieval, and report generating system for the state forest nursery. This system is designed to facilitate tree order processing and to assist management in decision making.

The data processing group, supervised by Bud Meador, also worked on many different projects during the year. Helen Tu, Anil Londhe, and Leigh Ihnen handled jobs for six different Iowa seed producers, and Ted Motoyama performed several large data analyses for Dr. Wolins on a project from General Motors Corporation. James Chen, who graduated at the end of winter quarter, worked on projects for the Iowa Development Commission as well as a number of university projects from the agronomy, psychology, and veterinary pathology departments.

An interesting software development project was performed by Anil Londhe and Bud Meador for the ISU Extension Service. An interactive software system was developed to analyze home insulation needs. It is currently being used as a public service during events such as state and county fairs and similar events to help individual home owners with analysis of the insulation needs of their dwelling.

Luis Escobar handled the data processing work on the Swine Producers Record System as well as a number of projects from the family environment and sociology departments. He also assisted in the development of a storage and retrieval system for clinical data from Veterinary Medicine.

In addition to James Chen, the section lost an experienced and able employee when Helen Tu moved to New Jersey. We wish all of the best for her and her family in their new location.

Several research projects were generated internally by section members. One of these, a study of algorithms for estimation under various criteria, culminated in a new SAS procedure named LONE. Dr. Gentle and one of his students developed this program which produces parameter estimates for the linear model under the L_1 criterion.

Several on-campus optimization projects involving linear and quadratic programming were conducted in the past year for the Center for Agricultural and Rural Development (CARD), and the department of agricultural economics. One large-scale linear programming project involved the interface of IBM's MPSX with a Fortran software package. In particular, the program was solved recursively over a ten-year time interval.

Another project consisted of using separable programming procedures on a 2000 x 30000 quadratic

programming model.

A study of the efficiency of new MPSX features was also conducted on a large-scale linear programming for CARD; Bill Boggess and Elaine White assisted V. A. Sposito in this study.

Survey Section

The Survey Section provides consultation and direct operational assistance to research workers in sample design and the planning and execution of sample surveys. The Section staff engages in all areas pertaining to the operational conduct of surveys, and professional staff members also conduct research and teach courses in the areas of sampling, survey design, and statistical methods.

Iowa is one of nine areas in the United States participating in the National Survey of Environment and Health. The Survey Section is cooperating with the Department of Urology, University of Iowa, in this year-long project. The study will employ a case-control design in which the cases will be incident cases, that is, persons in Iowa with cancer of the urinary bladder first diagnosed during 1978. The control group will be randomly selected and matched with incident cases on age and sex. It is expected that 450 incident cases and 900 controls will be identified throughout the state. The Survey Section is responsible for all field interviewing and the initial data edit. Analysis will be completed by researchers of the National Cancer Institute.

A study of the interest in post-secondary education by residents of the Council Bluffs area was conducted for the Iowa Coordinating Council on Post High School Education. Questionnaires were mailed to a one-fourth sample of households within 50 miles of Council Bluffs. Returns were received from 996 persons. Data were analyzed and the report submitted to the Council. The results of this study will aid educational institutions in the planning and coordination of their academic programs.

The data collection, editing, and storage phases of the College of Agriculture's extensive study of family farms were completed. A general profile of Iowa farms and farm families has been published, and individual researchers continue to use the data set in their areas of interest.

For the third consecutive year, the Survey Section has cooperated with the Iowa Office of Planning and Programming in the evaluation phase of the Iowa Comprehensive Employment and Training Act (CETA) program. Personal interviews were conducted with a sample of about 300 of the enrollees at the end of the program. Analysis also included all other enrollee and employer data collected throughout the duration of the program.

A list sample of about 100 confinement sow farrowing firms was used to gather information regarding the changes in technology and organizational structure of the pork production industry. As a follow-up to a mailed questionnaire, personal interviews were completed with the board chairmen as well as the managers of the sow farrowing firms. The Survey Section cooperated with the Department of Economics on this project.

Water rationing was the subject matter for a research project conducted this spring in Ames. A random sample of 110 Ames residents were interviewed regarding water use practices before enactment of water rationing, during the rationing period, and after its repeal. Questionnaires are currently being edited and coded, and final analysis will be made by researchers in the Department of Family Environment.

The Survey Section again conducted the biennial school census for the Ames Community School District. The primary purpose of this census, which is required by state law, is to obtain an accurate count of the number of persons less than 21 years old residing in the school district.

During the past year, personnel of the Survey Section designed and drew several household samples from telephone directories. A statewide sample was drawn for a study in horticulture investigating purchases of nursery stock; a sample from Des Moines was selected for a professor in family environment investigating consumer attitudes; a sample from Des Moines and environs was selected for a sociology student; and a sample from the telephone directories of two towns in southern Iowa was selected for a professor in sociology.

Assistance in questionnaire construction was given to a student investigating irrigation practices in Iowa, a student studying deer hunters, and a student investigating acute gastric dilatation in dogs.

A household sample from six central Iowa counties was selected for the Red Rock Area Community Action Program, Inc. An area sample was selected. In each county, areas thought to contain a higher than average proportion of low-income households were delineated and sampled separately at a higher rate than the rest of the county in order to increase the proportion of low-income households in the sample.

Area samples were selected in citrus growing areas of four states — Arizona, California, Florida, and Texas — for the Doane Agricultural Service. The samples are expected to yield about 1,500 citrus producing farms each in Arizona and California combined and in Florida and about 500 in Texas. The investigators are studying the use of pesticides on citrus crops.

An area sample expected to yield about 440 household interviews was selected for the Mayo Clinic. The sample was drawn from six townships in Olmsted, Wabasha, and Winona counties in Minnesota. The researchers are studying attitudes toward and the use made of a family practice clinic established in Plainview, Minnesota.

Samples of ISU administrators, faculty, and students were selected for a student in education. Because the student was primarily concerned with making comparisons among the six colleges, stratified samples with disproportionate allocation

to strata (colleges) were designed. The student was investigating perceptions of student personnel services at ISU.

A sample of 50 towns in Iowa with populations between 500 and 9,999 was selected for researchers in the department of forestry for a study of the number, kinds, and quality of trees growing in the towns. The towns were divided into four strata on the basis of their 1970 Census populations.

A sample of open country residents of Iowa was selected for researchers in agronomy in order to conduct a mail survey of farmers to discover which corn hybrids are being most widely planted. This is a continuing project in which persons responding are retained in the sample for two additional mailings. Results of this study will influence the selection of hybrids to be included in the Iowa Corn Yield Tests carried out by the University.

A computer program named 'SUPER CARP' has been developed by the Survey Section. The program is designed to compute estimates including estimated regression equations and estimated variances for sample survey data. The program is unique in that it contains methods for regression equations with independent variables subject to measurement (response) error. Many of the methods for treating regression equations with measurement error were developed at Iowa State by members of the Survey Section. Articles on the statistical methods have appeared or will appear in the Indian journal of statistics, *Sankhya C, Journal of the American Statistical Association,* and the *Annals of Statistics.* A tape of the program and a manual is available for $25. Persons interested in obtaining a copy of SUPER CARP should write Professor Wayne A. Fuller.

Off-Campus Consulting

In August, 1977, T. A. Bancroft, Chien-Pai Han, and several members of the ISU Statistical Numerical Analysis and Data Processing Section consulted in Ames with Dr. Chooichiro Asano, Professor, Research Institute of Fundamental Information Science, Kyushu University, Japan. Discussions involved (1) a proposed statistical program called the NISAN system and the related statistical principles and methodologies, and (2) the use of NISAN in obtaining a hierarchical cluster analysis using the references for conditionally specified models incorporating preliminary testing.

T. A. Bancroft consulted with a graduate student at Indiana University regarding certain background information relative to work on the student's doctoral thesis involving subset selection for problems of prediction in linear multiple regression and problems of non-linear regression and more general problems of model selection.

Gordon Booth consults with scientists at the National Animal Disease Center as well as at ISU. In addition to his consulting duties in Ames, he regularly collaborates with scientists at the University of Missouri (Columbia), the University of Nebraska (Lincoln), Kansas State University and the Meat Animal Research Center in Clay Center, Nebraska.

In addition to his primary responsibility of consulting, Dr. Booth is a member of two national committees: the National Statistics Coordinating Committee-SEA, of which he is chairman and the National Modeling Coordinating Committee. The former is concerned with the efficient delivery of statistical expertise to agricultural research while the latter deals with simulation modeling of biological and agricultural systems.

Jeff Goebel was in Washington, D. C., August 29-31 to consult with members of the Soil Conservation Service, Statistical Reporting Service, and the Economic Research Service regarding various projects which are in process involving these groups and the Survey Section of the Statistical Laboratory.

David Harville assisted Professor Shayle R. Searle and Dr. Dick Quaas from Cornell University on their preparation of a technical report on mixed-model statistical procedures, November 16-19, 1977.

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C. P. Cox consulted: (1) with members of the biochemistry department on statistical procedures for detecting a characteristic pattern of different iso-enzyme concentrations in malignant tissue, and on the possibility of using discriminant function analysis for the detection of characteristic patterns of different iso-enzymes in malignant tissue; (2) with members of the fisheries and wildlife biology department on the design of a questionnaire seeking information on the importance of scrapes in deer hunting; and (3) with members of the agronomy department in designing a complex factorial experiment to investigate the effects of soil types and temperatures on nematode concentration.

Special Topics Meeting Held at Ames

Iowa State University hosted the Special Topics Meeting on Time Series Analysis of the Institute of Mathematical Statistics May 1-3. John Tukey, Princeton University, delivered the keynote address on "Can we predict where time series analysis should go next?"

The paper sessions covered such topics as parametric modeling, state space representation, control theory, continuous processes, econometric and engineering applications, seasonal adjustments, robust methods, and graphics and computer packages. There were 15 invited speakers and 16 contributed papers. Approximately 180 registrants attended the sessions.

J. Jeffery Goebel served as assistant program secretary in charge of local arrangements for the meeting and Wayne A. Fuller was a member of the program committee.

Current Research

Statistical research in theory and methodology is a regular activity of the Statistical Laboratory staff and is financed by various sources. Projects of special interest to regular university research programs are supported by the Statistical Laboratory budget. Cooperating campus research institutes and the agricultural experiment station provide additional funds. Off-campus contracts and grants continue to be a major source of funds for the research of students and faculty.

AES Project 890

Dr. O. Kempthorne has worked on Project 890 of the Iowa Agriculture and Home Ecomonics Experiment Station under the title: "Design of Experiments and Analysis of the Data." The areas worked on are the role of randomization in comparative or causal experiments, the role of randomness of sampling in finite population study, the foundations of statistics, with particular reference to the use, applicability, and interrelations of the principles of sufficiency, conditionality, and likelihood.

AES Project 2039

The U.S. Bureau of the Census continues to support joint research in sample survey and time series methodology through Project 2039 with the Agriculture Experiment Station. Personnel working on the project include Wayne Fuller, principal investigator, Jeffery Goebel, Fred Dahm, and Bisu Bhattacharyay.

The properties of least squares estimators for autoregressive time series with some roots greater than or equal to one were studied. Properties of the prediction error were obtained for models with the largest root less than, equal to, and greater than one. Earlier work on autoregressive time series was extended to stochastic difference equations containing fixed regressor variables. The limiting distributions of certain likelihood ratio tests of the hypothesis of unit roots were derived and tabulated.

The estimation of regression equations with independent variables subject to measurement error was studied. The limiting distribution of the regression estimator constructed after correcting the correlation matrix for attenuation was obtained.

Growth Models

Cooperative research with the Statistical Reporting Service of the U.S. Department of Agriculture is being conducted under the direction of Wayne Fuller, project leader. Cheryl Hammond and John Prebihalo were graduate assistants on the project. Nonlinear models for growth of sorghum and corn were investigated. Transformations and other methods of treating heterogeneous error variances were investigated. Methods of incorporating prior information into the forecast equations were studied.

AES Project 2155

Research in agricultural sample survey methodology continues in the Survey Section under Agriculture Experiment Station Project 2155, with Roy D. Hickman as project leader. Cooperative work with the Soil Conservation Service (SCS) of the U.S. Department of Agriculture includes estimation procedures, variance estimation techniques, alternative sampling designs, questionnaire construction, and computer edits of large data sets. A major portion of this project is the SCS National Erosion Inventory, a three-phase survey containing about 200,000 specific sample sites. Field work has been completed for Phase I which focuses on sheet, rill, and wind erosion, land use, potential cropland, prime farmland, and conservation needs. Processing of these data, development of estimation procedures, and design of a quality control field check have been areas of effort during the year.

Of interest in Phase II of this survey are erosion rates on gullies, streambanks, channel bottoms, construction sites, roads, and roadsides. Training of SCS field personnel has been completed for this phase, and field work has begun. Sediment yields will be investigated during Phase III. The SCS National Erosion Inventory will serve as: (i) the basis for a report to Congress on the nation's agricultural resources; (ii) a guide for SCS to use in developing future conservation programming; and (iii) a pilot project for a much larger survey that was mandated by recent Congressional action under the Soil and Water Resources Conservation Act of 1977.

Work continued on the storage, retrieval, and analysis of the interpretive data of soil series in the United States. Series records presently stored number over 11,000 and SCS field staff continue to revise and update the data base. New techniques of analysis and display which will aid the SCS in finding new uses of the data are being developed. Other government and private agencies periodically request subsets of the interpretive data file for use in their work. Harvey Terpstra, who directs this project, continues to work closely with regional and federal SCS personnel in the development of this data storage and analysis system.

Construction of area sampling frames continue under a cooperative agreement with the Statistical

Reporting Service (SRS), USDA. Strata are constructed according to degree and type of cultivation as indicated by maps, aerial photographs, and other information furnished by the states. Land within strata is then subdivided into area sampling units. These state area frames are used by the SRS to design and draw samples included in their agricultural surveys. This year sampling frames were completed for Mississippi, Louisiana, and Virginia.

Order Statistics and Nonparametric Statistics

With support of the above-named Army Research Office grant, H. A. David and V. S. Shu have extended their investigations on the robustness of linear functions of order statistics as estimators of location in the presence of an outlier to (a) estimators of scale and (b) estimators of location, possibly adaptive, not expressible as linear functions of order statistics. Under the model of a single outlier with a distribution differing either in location or scale from the normal target population, it is possible to obtain exact numerical results for the bias and mean square error in (a); Monte Carlo methods are generally needed for (b).

In closely related work a comparison has been made of outlier models and mixture models. Also the relevance of tests for outliers when robust estimators are used has been briefly examined.

During a short visit supported by ARO, W. J. Conover of Texas Tech University prepared articles, with R. L. Iman, on approximations of the critical region for Spearman's rho and on the squared ranks test for variances.

Mathematical and Statistical Genetics

Research in mathematical and statistical genetics is supported by Project 1669, Iowa Agriculture and Home Economics Experiment Station, and the National Institutes of Health. Edward Pollak and Oscar Kempthorne are project leaders.

Drs. E. Pollak and T. H. Emigh continued research on finite populations with several age groups present at any time. It was assumed that the number of individuals in a particular age-sex class and the distribution of ages of parents of a newborn individual of a specified sex remain the same at all times. The probability of fixation of a neutral gene was calculated for both monoecious and dioecious populations. In addition, an inbreeding effective number was obtained for a dioecious population under the further assumptions that mating is random given the ages of the mates, that the numbers in all age-sex classes are large, and the probabilities of parents in the various age-sex classes are the same for male and female offspring.

Dr. O. Kempthorne examined the logical, epistemological, and statistical aspects of nature-nurture data interpretation. In the resulting paper which appeared in *Biometrics,* the nature of the reasoning processes applied to the nature-nurture question was discussed in general and with particular reference to mental and behavioral traits. Data analysis, the analysis of variance, and the nature of causation were considered. The notion that data analysis can establish causation was attacked, as was the idea that heritability is meaningful in the human mental and behavioral arena.

Dr. Kempthorne also made considerable effort to make clear the nature of the mathematical and statistical arguments in the germinal 1918 paper of R. A. Fisher on the interpretation of data from a population in which mating is assortative.

Dr. J. L. Cornette examined the progress toward equilibrium of the frequencies of sex-linked genes in age — structured populations. By examining several elementary discrete and continuous time overlapping generation models, Dr. Cornette demonstrated that the normal condition is for gene frequencies in either sex to oscillate above and below the eventual equilibrium frequency and that, specifically, they do oscillate in models for which the maximum age at death is finite.

J. R. Sedcole has begun research on selection in populations in which the probability that an individual survives is dependent both on its own genotype and the genotypes of the other individuals of the same species against which it competes.

J. W. Lewis has continued his research on a class of models involving selection, with the interaction of a diploid host with a haploid pathogen. Each is assumed to have two alleles. Several possible equilibria have been found and conditions under which they are stable have been examined.

Linear Statistical Inference

Research is being pursued on various topics related to linear models. This work is being supported by Air Force Office of Scientific Research Grant No. 76-3037, entitled "New Techniques for Linear Statistical Inference." Dr. David Harville is the principal investigator and Raghu Kackar and William Sallas have served as research assistants. Among topics that have been studied are: representations for constrained mixed-model estimation; alternative formulations and procedures for the two-way mixed model; relationships between results on Kalman filtering, smoothing, and prediction found in the engineering literature and various results on linear models found in the statistical literature; and the development of test and interval procedures for linear combinations of the effects of mixed linear models for the case where the ratios of the variance components are unknown and must be estimated from the data.

Optimization Problems

Constructive Approaches to Infinite-Dimensional Statistical Optimization Problems: This research, much of it undertaken by H. T. David and Geung Ho Kim, applies a certain constructive programming approach to several infinite-dimensional constrained optimization problems of interest in probability, and statistics.

This constructive approach, as applied to nonlinear problems, systematically entwines two elementary strains: the notions of sub-gradient and support from convex analysis, and the notion of weak duality from mathematical programming.

Optimization proceeds by verifying a trial solution, thus skirting the issue of existence, so that no structure beyond linearity, i.e., no topological structure, typically need be assumed for the domains involved.

Many of the problems being investigated concern information functionals of various types; for example, restricted optimizations of mutual information, and entropy optimization problems pertaining to Markov chains. Another set of problems are linear problems of special applied interest, for example in reliability and type-token analysis, some of these utilizing Tchebychev system properties. A third set of problems concern optimum estimation, with criteria alternative to mean square error and restrictions alternative to unbiasedness.

Science and Humanities Research Institute (SHRI)

The research partially supported by SHRI is mainly of a theoretical nature. Glen Meeden has been studying various statistical estimation procedures, mainly from a Bayesian point of view. He has established the admissibility of several estimators, admissibility being a sine qua non of a theoretically desirable estimator. Characterizations of statistical distributions have been a common interest of Meeden, Dean Isaacson, and especially Barry Arnold. Isaacson is also continuing his work on Markov chains. There is a very pleasing interaction among the above and other members of the "theory group."

C. P. Han has been very active in the areas of multivariate analysis; inference based on conditional specifications; and sample survey theory. The last two topics have also been investigated by B. V. Sukhatme. One important subject treated by both concerns ways of using information on auxiliary variables to improve inferences on the variable of primary interest in a sample survey.

B. V. Sukhatme also initiated research to develop a unified approach to designing surveys and to drawing inference in regard to symmetric functions of population values.

Individual Research

C. P. Cox and Wendell Ponder researched the problem of comparing different treatment effects when several observations are obtained and the trend structures differ for different individual experimental units. They are preparing a paper to report the analysis procedures developed.

In addition, Cox and Johnson Osho examined a simple mathematical model for radio-immunoassay as a basis for data analyses on the effects of variance heterogeneity.

William Meeker collaborated with Thomas Ryan, Brian Joiner, and Barbara Ryan, the developers of MINITAB, in order to implement time series commands for this popular statistical package. Dr. Meeker also continued research on accelerated testing and he is investigating some aspects of statistical prediction. These latter projects are being done in collaboration with the statisticians at the General Electric Corporate Research and Development Center in Schenectady, New York.

Tukey Presents Short Course

John W. Tukey, Professor of Statistics, Princeton University, and a member of the National Academy of Sciences, and an associate, Paul Velleman, Cornell University, conducted an intensive short course entitled "New Techniques in Data Analysis" at the Statistical Laboratory May 30-June 3, 1978. In addition to ISU faculty and graduate students, some 15 visitors from other Midwestern universities attended. Dr. Tukey's course objectives were to establish a framework of thought which would facilitate one's understanding of the techniques presented in two of his books: *Exploratory Data Analysis and Data Analysis and Regression.*

William J. Kennedy handled the local arrangements for the short course.
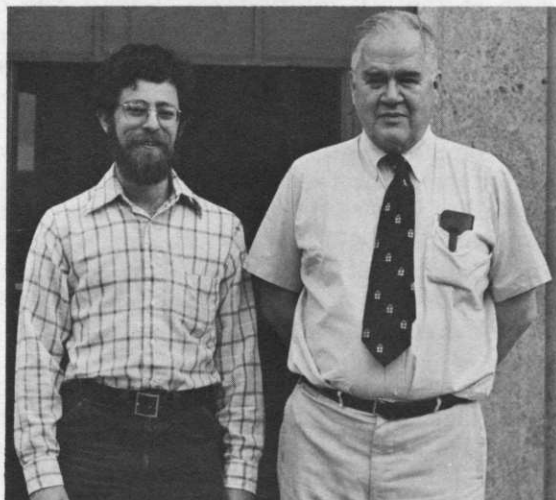
Drs. Tukey and Velleman at the Memorial Union, ISU.

Professional Activities

Officers in the American Statistical Association for 1978 from the Statistical Laboratory are: H. A. David, Board of Directors; Bill Kennedy, chairman, and James Gentle, program chairman elect of the Statistical Computing Section. Dr. Gentle also serves as president of the Iowa Chapter of the ASA.

Ted Bailey attended a short course "Understanding SAS-GLM" (statistical analysis system-general linear models procedure) in Bethesda, Maryland, November 14-15. The course was sponsored by the Continuing Education Institute of the University of Florida, Gainesville.

On February 16-17, Harold D. Baker assisted in training interviewers selected to work on a survey for the Mayo Clinic in Rochester, Minnesota. He also served on a review committee for the National Cancer Institute in Bethesda, Maryland, from March 21-23.

At the ASA meetings in Chicago, H. T. David attended a meeting of the Committee of Presidents of Statistical Societies as outgoing Visiting Lecturer Program Chairman.

H. T. David was in India December 7-25 to attend the 41st session of the International Statistical Institute in New Delhi, and the International Conference on Optimization in Statistics held in Bombay. The topics of his talks at these meetings are given elsewhere in this issue. He reported on the prominent roles assumed by ISU graduates at the ISI meetings — DeGraft-Johnson, chairman of the nominating committee; Boruch and Isaki, organizers of invited sessions.

Chien-Pai Han represented the Department of Statistics at the 5th International Symposium on Multivariate Analysis held in Pittsburgh June 19-24. He gave a talk on "Discriminant analysis based on binary and continuous variables."

Oscar Kempthorne served on the Committee on Fellows for the Institute of Mathematical Statistics. Dr. Kempthorne also participated in the Airlie House Meeting on "Theoretical and Applied Statistics" sponsored by the National Research Council and the National Academy of Science (NRC-NAS) in Washington, D. C., February 9-11.

William Kennedy chaired a workshop on numerical algorithms in the Computer Science and Statistics 11th Annual Symposium on the Interface at Raleigh, North Carolina, on March 5-7. At this symposium, Drs. Kennedy and Gentle presented a joint paper listed elsewhere in this issue.

William Meeker attended a meeting of the steering committee for a National Science Foundation supported project entitled "Diagnostic and Instructional Services for College Students of Statistics," in New Orleans, Louisiana, October 21-22. During the year, Dr. Meeker also participated in an external review of materials to be put in the data base that is being created as part of this project.

Dr. Meeker has been elected to a three year term as the department representative to the Sciences and Humanities Representative assembly.

Richard D. Warren served as a consultant for the Integrated Rural Development Project (AID/Experience Incorporated) in Kingston, Jamaica, June 26-July 3, 1977.

Papers Presented, Lectures, and Seminars

At the 1977 joint meetings of the American Statistical Association and the Biometric Society, Chicago, August 15-18:

Andriano, Kim, James E. Gentle, and **V. A. Sposito:** "Direct estimation of the mode";

Chen, Jengrong J. and **James E. Gentle:** "Identifying multiple outliers in regression models";

Dickey, David (North Carolina State University) and **Wayne A. Fuller:** "Distribution of the first order autoregressive estimator";

Esimai, Grace O. (University of Nigeria) and **Chien-Pai Han:** "Double sampling in multi-auxiliary regression estimation based on conditional specification";

Hanson, Thomas A. (Corning Glass, Corning, N. Y.) and **James E. Gentle:** "Variable selection in linear regression using a L_1 criterion";

Hasza, David (Kansas State University) and **Wayne A. Fuller:** "Estimation for autoregressive processes with unit roots";

Kempthorne, Oscar: "Logical, epistemological, and statistical aspects of nature-nurture data interpretation";

Meeker, William Q. Jr.: "TSERIES — a user-oriented computer program for identifying, fitting, and forecasting ARIMA time series models";

Meeker, William Q. Jr. and **Gerald J. Hahn:** "Asymptotically optimum over-stress tests to estimate the survival probability at a condition with a low expected failure probability";

Sukhatme, B. V. and **Lal Chand** (J. N. Agricultural University, Jabalpur, India): "Multivariate ratio-type estimators."

At the Chicago meetings, William Kennedy chaired the session "Comparison of Algorithms for Least Squares Computation" and James Gentle was a discussant. Dr. Kennedy was a discussion leader for the session "Numerical Accuracy in Matrix Computations." Dr. Gentle chaired a contributed papers session, "Selected Topics in Statistics," and a round-table discussion session, "L₁ Estimation."

Wayne Fuller was a discussant for "The Interface Between Statistical Methodology and Statistical Practice."

Oscar Kempthorne chaired a session "Biological Interference on Humans from Data on Relatives, with Particular Reference to IQ and Sociobiology."

B. V. Sukhatme was a discussant at a session of contributed papers on sampling.

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At the Annual Meeting of the Rural Sociological Society at Madison, Wisconsin in August, 1977:

Mulford, Charles L., **Richard D. Warren,** and Gerald E. Klonglan: "Developing a framework to evaluate effectiveness of university extension";

Mulford, Charles L., Gerald E. Klonglan, and **Richard D. Warren:** "Effect of size on Etzioni's compliance model: a path analysis";

Marshall, Christopher E., Gerald E. Klonglan, **Richard D. Warren,** Keith A. Carter, Frank A. Fear, and Rodney F. Ganey: "Social indicator research at Iowa State University, progress and directions."

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At the IMS Special Topics Meeting on Times Series held at ISU May 1-3, 1978:

Dickey, David and **Wayne Fuller:** "Distribution of likelihood ratio test statistics for non-stationary time series";

Hasza, David and **Wayne Fuller:** "Properties of prediction for autoregressive time series."

William Q. Meeker Jr. chaired a contributed papers session and Wayne A. Fuller chaired an invited papers session for the Special Topics Meeting.

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Bailey, Ted: "Some results of simulation studies comparing various selection systems during the development of inbred lines," at the Quantitative Genetics Meeting, Des Plaines, Illinois, February 27-March 2.

Bubolz, Thomas A. and **James Gentle:** "SAS applications in a three-course sequence in statistical computing," at the SAS Users Group, International Conference in Las Vegas, Nevada, January 30-February 1.

David, H. A.: "Robust estimation in the presence of outliers" at an Army Research Office Workshop on Robustness in Statistics in Durham, North Carolina, April 10-12.

David, H. T.: "Six faces of randomness," lecture for the Math Colloquium at Clarkson College, Potsdam, N. Y., November 15-16.

David, H. T. and **Geung Ho Kim:** "Bivariate distributions as saddle points of mutual information," at the Math-Statistics Colloquium, McGill University, Montreal, Canada, November 17-18.

"Mathematical programming formulations of statistical optimization problems" for the Math Colloquium at Clarkson College, Potsdam, N. Y., November 15-16.

David, H. T., Pam Doctor (Batelle Memorial Institute, Richland, Washington), and **Gabriela Stangenhaus:** "Two topics in optimum estimation," at the 41st session of the International Statistical Institute in New Delhi, India, in December.

David, H. T. and **Geung Ho Kim:** "Weak duality and some infinite dimensional optimization problems of probability and statistics," at the International Conference on Optimization in Statistics, Bombay, India, in December.

Fuller, Wayne A.: "Estimation of the parameters of stochastic difference equations," presented at NBER-NSF Seminar on Time Series at the University of Chicago, November 18.

"Are past failures forgiven and past successes forgotten?" (seminar) presented at North Carolina State University, September 31, 1977, and at the Bureau of the Census, Washington, D. C., February 1.

"Regression analysis for time series," presented at Oklahoma Chapter of the American Statistical Association, March 16.

"Estimation for autoregressive processes," (seminar) at the University of Tulsa, March 17.

Gentle, James: "Identification of multiple outliers in regression models," Department of Statistics, University of Manitoba, August 23.

Gentle, James and **William J. Kennedy:** "Best subsets regression under the minimax criterion," at the 11th Annual Symposium on the Interface of Statistics and Computer Science in Raleigh, N. C., March 5-7.

Ghosh, Malay: "Admissibility in finite problems with a sampling example," at the New Delhi Meeting of the Institute of Mathematical Statistics.

Goebel, Jeff: "Sampling concepts, reliability, and selected sample areas," (seminar) presented at regional meetings of SCS sedimentation geologists and engineers, in Washington, D. C., on June 28, 1977, in Fort Worth, Texas, on October 18, and in Albuquerque, New Mexico, on November 2.

Esimai, Grace O. (University of Nigeria) and **Chien-Pai Han:** "Multi-auxiliary regression estimation based on conditional specification," at the Institute of Mathematical Statistics Meeting in Lexington, Kentucky, March 22-24.

Han, Chien-Pai and **Ching-tsao Tu** (American Cyanamid Company, Princeton, New Jersey): "Discriminant analysis based on binary and continuous variables," at the 5th International Symposium on Multivariate Analysis, University of Pittsburgh, June 18-24.

Harville, David: "Maximum likelihood and pseudo-Bayesian approaches to mixed model estimation and prediction" (seminar) presented to the Biometrics Unit, Cornell University, Ithaca, New York, November 17.

Hickman, Roy: "Sources of error in sample surveys," at the Central Region Research Conference in Agricultural Education, August 2.

Isaacson, Dean: "Ergodicity versus strong ergodicity," at the Department of Mathematics and Business Analysis at Miami University of Ohio, March 3-7.

"Markov chains and their applications," at Macalester College, St. Paul Minnesota, February 27, and at Miami University of Ohio, March 3-7.

Kempthorne, Oscar: "Varieties of inference" at the fall meeting of the Iowa Chapter of the ASA, Grinnell College, Grinnell, Iowa, October 5.

"Inference in medical research and development," at the 33rd Annual Princeton Conference on Applied Statistics, Princeton, New Jersey, November 30-December 2.

"Theory of quantitative genetics," (seminar) at Princeton University, November 30-December 2.

"Roles of randomization," at the Statistics Colloquium, Department of Statistics, Florida State University, January 12.

"Algebraic structures in experimental design," at Florida State University, February 18.

"Tests of significance in experimental and observational contexts," on May 2, in the University of Minnesota Seminar Series, "Seminar on the work of R. A. Fisher."

Meeker, William Q. Jr.,: "Using TSERIES to identify, fit, and forecast time series," (seminar) presented at the Statistics Seminar Series, General Electric Corporate Research and Development Center, Schenectady, New York, July 29, 1978.

Meeker, William Q. Jr., P. I. Feder, and G. J. Hahn, "Evaluating the properties of experimental designs for fitting regression relationships," at the 21st Annual Technical Conference, sponsored by the Chemical Division of the American Society for Quality Control and the Section on Physical and Engineering Sciences of the American Statistical Association, Detroit, Michigan, October 21.

Meeker, William Q. Jr.: "EXPLOR II — a tool for computer aided experimental design," (statistics colloquium) Pennsylvania State University, June 22, 1978.

Pollak, Edward: "Conditions under which the mean fitness does not increase with selection," (seminar) Life Sciences, ISU, September 28.

Sposito, V. A. and **J. M. Trzeciak** (University of Arizona, Tuscon): "Maximization of signomials and polynomials," at the ASME 1977 Design Automation Conference, Chicago, September 27.

Haque, A. F. M. and **V. A. Spositio:** "Minimum bound estimation," at the Annual Bangladesh Engineers Convention December-January, 1978.

Haque, A. F. M., V. A. Sposito, and H. Meeks: "Productivity improvement through scheduling," Annual Science Conference of Bangladesh, December-January, 1978.

Haque, A. F. M., V. A. Sposito, and H. Meeks: "Stopping rules in Monte Carlo sampling," at the First National Statistical Conference, Dacca, March 3, 1978.

Haque, A. F. M., V. A. Sposito, and H. Meeks: "Halting techniques for random sampling in sequencing programs," at the International Conference in Systems Modelings, Bangkok, Thailand, May 8-12.

Strahan, R. F.: "On rejecting substantive hypotheses because of counter-directional results," at the Convention of the American Psychological Association in San Francisco, California, August 23-27.

Strahan, R. F.: "Alpha is not omega: on inferring scale dimensionality from homogeneity," and "On the nonintuitive nature of the correlation coefficient: subjective estimation of three-variable relations," at the Annual Meeting of the American Association for the Advancement of Science in Washington, D. C., February 12-17.

Van Nostrand, Craig: "Quality control short course," Iowa State University, May, 1978.

Warren, Richard D.: "Measurement in social sciences," "Organizational effectiveness," and "The use of statistics in social sciences," (lectures) presented for the Mid-America State Universities Association (MASUA) during 1977-1978.

Warren, Richard D.: "Developing and analyzing scales for agricultural education," at the Research Conference on Agricultural Education-Central Region, Ames, Iowa, August, 1977.

Barb, K. H., W. J. Goudy, and **R. D. Warren:** "Aging and changes in the preferred age of retirement," at the Annual Meeting of the Gerontological Society, San Francisco, California, November, 1977.

Fear, Frank A., Gerald E. Klonglan, and **Richard D. Warren:** "Social indicators and needs assessment: anatomy of a pilot project," at a conference sponsored by the College of Agriculture and the Cooperative Extension Service at the University of Kentucky, January, 1978.

Alumni Banquet Held in August

A highlight of the summer of '77 was the alumni banquet held during the ASA meetings in Chicago in the Blackhawk Restaurant. The more than 100 participants included a wide spectrum of alumni, past and present faculty, spouses, students, and friends. H. A. David, the director of the Statistical Laboratory, reviewed highlights of the past five years. Oscar Kempthorne acted as MC and provided more philosophical comments on the Statistical Laboratory and on statistics in general. Responding on behalf of different generations of alumni were Walt Federer (Ph.D. '48), Robert White (Ph.D. '63), and Dave Dickey (Ph.D. '76). Everyone was particularly pleased to have H. O. Hartley (Professor, 1953-63) present with his wife and daughter. Hartley entertained the group with some pleasant reminiscences.
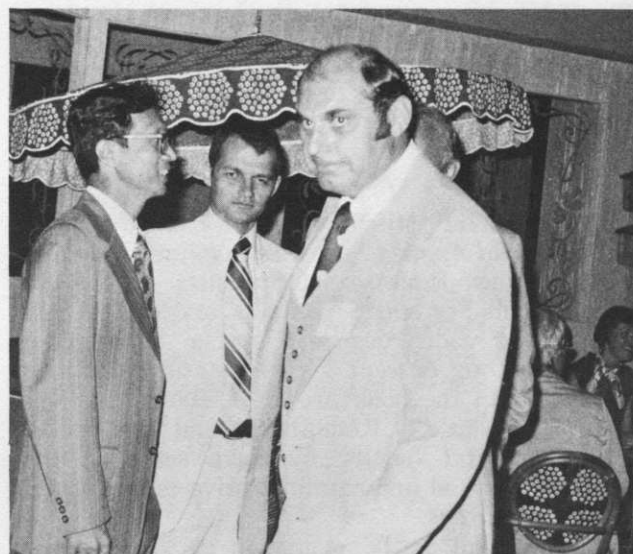
Dr. Chien-Pai Han corresponded with alumni and handled arrangements for the alumni banquet. Pictured above from left to right are Dr. Han, Michael Hidiroglou (Ph.D. '74), and Sidney Addelman (Ph.D. '60).

Unfortunately, T. A. Bancroft, director, 1950-1972, who retired from ISU at the end of May 1977 was unable to attend. Subsequently, Drs. David and Han presented him, at his home in Ames, with a bound volume of signatures from those at the banquet and with a shortwave AM/FM radio. At his request, the bulk of the contributions made in his honor by many friends was added to the T. A. Bancroft Award Fund.

The banquet was evidently enjoyed by all. Surprisingly it was a first for the Statistical Laboratory, founded in 1933! Clearly the event should be repeated at somewhat more frequent intervals.

Two Zyskind Memorial Lectures Presented

Two distinguished statisticians gave George Zyskind Memorial Lectures during the year.

C. R. Rao, Jawaharlal Nehru Professor in the Indian Statistical Institute, presented the second Zyskind Lecture, "Statistics: Data, Analysis, and Thinking." Rao, a Fellow of the Royal Society, is internationally known for his contributions to statistical theory and biometric methods, and as the author of several major statistical theorems which are incorporated in modern statistics books.

Ingram Olkin, former chairman of the Department of Statistics at Stanford University, presented the third lecture, "Some Applied Multivariate Models with Special Symmetries." Olkin is a former editor of the *Annals of Mathematical Statistics* and a co-author of *Selecting and Ordering Populations: A New Statistical Methodology.*

The lectures honor the late George Zyskind, and speakers are chosen to reflect Dr. Zyskind's varied interests in statistics.

Publications and Dissertation Abstracts

H. A. David edited *Contributions to Survey Sampling and Applied Statistics,* a volume honoring H. O. Hartley, Professor of Statistics at I. S. U. 1953-63. The Festschrift contains articles by past and present colleagues and former students of Hartley. Among current I. S. U. statisticians who contributed to the book are T. A. Bancroft, H. A. David, J. E. Gentle, O. Kempthorne, and V. S. Shu.

Departmental faculty members serve in the following editorial and administrative capacities for statistical journals:

H. A. David is the chairman of the editorial board for *Biometrics.*

H. T. David is an associate editor of the methods and theory section of the *Journal of the American Statistical Association.*

C. P. Han is a member of the editorial board of *Communications in Statistics.*

With W. J. Kennedy, James Gentle is co-editor of the Algorithms Section in *Communications in Statistics, Part B.* Dr. Gentle is also a member of the editorial board of the Institute of Mathematical Statistics Committee on Mathematical Tables.

Malay Ghosh is a member of the journal committee of *Sankhya A* and *B.*

In addition to being an associate editor of *Biometrics* and *Theoretical Population Biology,* Oscar Kempthorne is also on the editorial advisory board of the *Journal of Statistical Computation and Simulation.* Kempthorne also serves on the editorial board of the *Journal of Statistical Planning and Inference.*

William J. Kennedy is an associate editor of *The American Statistician* and a co-editor of *Selected Tables in Mathematical Statistics.* Dr. Kennedy is also a member of the editorial board of *Communications in Statistics.*

B. V. Sukhatme serves on the editorial board of the *Journal of the Indian Society of Agricultural Statistics.*

Leroy Wolins is a member of the board of editors for *Educational and Psychological Measurement.*

Abstracts of papers and books published by staff members and graduate students and dissertation abstracts are included in this section. When research was conducted at Iowa State but the author has since accepted a new position, his current location is listed in parentheses after his name. Some of these publications are included in the Statistical Laboratory's Reprint Series (SLRS), and copies are available upon request. These are indicated by an asterisk (*).

Books

David, H. A., editor. *Contributions to Survey Sampling and Applied Statistics.* Academic Press. New York. 1978.

Pollak, Edward, Oscar Kempthorne, and **Theodore B. Bailey, Jr.,** editors. *Proceedings of the International Conference on Quantitative Genetics August 16-21, 1976.* The Iowa State University Press. Ames. 1977.

Book Reviews

*Arnold, Barry C. An introduction to probability theory and mathematical statistics, by V. K. Rohatgi. Reviewed in *Journal of the American Statistical Association* 73:361 (March, 1978) 219-220. SLRS 433.

Bancroft, T. A. On the history of statistics and probability, edited by D. B. Owen. Reviewed in the *Journal of the American Statistical Association* 73:361 (March, 1978) 229-230.

Groeneveld, Richard A. Introduction to statistics and computer programming by Carl F. Kossack and Claudia I. Henschke. Reviewed in *Technometrics* 19 (1977) 341-2.

Kempthorne, Oscar. Fundamentals of path analysis and population genetics, by C. C. Li. Reviewed in *The Journal of Heredity* 68 (1977) 270-271.

Problem Solution

Groeneveld, Richard A. "Binomial sum and legendre polynomials," solution to problem E 2601. Published in *American Mathematical Monthly* 84:9 (November, 1977) 742.

Published Research

*Andriano, Kim. Consistency of the normal equations via linear duality. *Communication in Statistics; Simulation and Computation* B6:1 (1977) 97-99. SLRS 417.

By appealing only to well-known results in linear programming, this note proves that the normal equations are always consistent.

*Arnold, Barry C. Recurrence relations between expectations of functions of order statistics. *Scandinavian Acturarial Journal* (1977) 169-174. SLRS 421.

General recurrence relations are derived for expectations of functions of one or more order statistics. Several examples are presented. The results also hold for order statistics from exchangeable sequences and for concomitants of order statistics.

*Arnold, Barry C. and Glen Meeden. A characterization of the uniform distribution based on summation modulo one, with application to fractional backlogs. *The Australian Journal of Statistics* 18:3 (1976) 173-175. SLRS 419.

Let X and Y be independent random variables taking on values in (0,1). Suppose that X and X + Y (mod 1) have the same distribution and Y does not have its distribution concentrated on a set of the form $\{i/m : i = 0,1,2,...,m-1\}$. Under these circumstances it is proved by elementary means that X is uniformly distributed on [0,1). The result may be compared with an earlier result of Goldman who assumed X and Y were identically distributed. An example is given which shows that it is not possible to drop the analogous assumption of identical distributions in Laha and Lukacs' well known normal characterization (i.e. $X \overset{d}{=} Y$ and $(X + Y)/\sqrt{2} \overset{d}{=} X$ imply X is normally distributed).

***Bancroft, T. A.** and **Chien-Pai Han.** Inference based on conditional specification: a note and a bibliography. *International Statistical Review* 45 (1977) 117-127. SLRS 405.

It is proposed that a new terminology, "inference based on conditional specification," is a more appropriate designation for inference procedures incorporating preliminary test(s). A justification for using this terminology and inference procedure is given. A bibliography of papers written in this area has been compiled and a classification of these papers is also given.

***Bailey, Theodore B., Jr.** Selection limits in self-fertilizing populations following the cross of homozygous lines. *Proceedings of the International Conference on Quantitative Genetics:* 399-412. Iowa State University Press. 1977. SLRS 408.

Journal Paper J-8740, Iowa Agriculture and Home Economics Experiment Station, Project 0101.

Brown, R. W., J. L. Thomas, H. M. Cook, J. L. Riley and **G. D. Booth.** Effect of environmental temperature stress on intramammary infections of dairy cows and monitoring of body and intramammary temperatures by radiotelemetry. *The American Journal of Veterinary Research* 38:2 (1977) 181-187.

Hughes, D. E., G. W. Pugh, Jr., and **G. D. Booth.** Induced infectious bovine keratoconjunctivitis: vaccination with whole cell bacterins of *Moraxella bovis* mixed with Freund's incomplete adjuvant. *The American Journal of Veterinary Research* 38:11 (1977) 1905-1907.

Pomeranz, Y., G. S. Robbins, J. T. Gilbertson, and **G. D. Booth.** Effects of nitrogen fertilization on lysine, threonine, and methionine of hulled and hull-less barley cultivars. *Cereal Chemists* 54:5 (1977) 1034-1042.

Pugh, George W., Jr., David E. Hughes and **Gordon D. Booth.** Experimentally induced infectious bovine keratoconjunctivitis: effectiveness of a pilus vaccine against exposure to homologous strains of Moraxella bovis. *The American Journal of Veterinary Research* 38:10 (1977) 1519-1522.

Pugh, G. W. Jr., D. E. Hughes, and **G. D. Booth.** Serologic response of vaccinated cattle to strains of *Moraxella bovis* isolated during epizootics of keratoconjunctivitis. *The American Journal of Veterinary Research* 39:1 (1978) 55-57.

Taylor, H. M., E. Burnett, and **G. D. Booth.** Taproot elongation rates of soybeans. *Journal of Agronomy and Crop Science* 146 (1978) 33-39.

Dahlgren, R. B., A. Wywialowski, **T. A. Bubolz** and V. L. Wright. Influence of knowledge of wildlife management principles on behavior and attitudes toward resource issues. *Transactions of the North American Wildlife and Natural Resources Conference* 42 (1977) 146-155.

Wright, V. L., **T. A. Bubolz,** A. Wywialowski, and R. B. Dahlgren. Characteristics of individuals involved in different types of hunting. *Transactions of the North American Wildlife and Natural Resources Conference* 42 (1977) 207-215.

Bowerman, Bruce (Miami University of Ohio), **H. T. David,** and **Dean Isaacson.** The convergence of Cesaro averages for certain nonstationary Markov chains. *Stochastic Processes and Their Applications* 5 (1977) 221-230.

If P is a stochastic matrix corresponding to a stationary, irreducible, positive persistent Markov chain of period $d > 1$, the powers p^n will not converge as n $\to \infty$. However, the subsequences P^{nd+k} for k = 0,1,..., d-1, and hence Cesaro averages $\sum_{k=1}^{n} P^k/n$, will converge. In this paper we determine classes of nonstationary Markov chains for which the analogous subsequences and/or Cesaro averages converge and consider the rates of convergence. The results obtained are then applied to the analysis of expected average cost.

***Cornette, James L.** Sex-linked genes in age-structured populations. *Heredity* 40:2 (1978) 291-297. SLRS 438.

Journal Paper No. J-8907 of the Iowa Agriculture and Home Economics Experiment Station. Project 1669; partial support by National Institutes of Health Grant GM 13827.

We study the progress towards equilibrium of the frequencies of sex-linked genes in elementary discrete time models of age-structured, overlapping generation populations. It is found that, if a finite upper age limit is assumed, the difference in the frequencies of an allele in males and females will oscillate as in the familiar nonoverlapping generation models, although the oscillations may be irregular. Monotonic convergence of that difference, as found by Nagylaki (1975) in continuous-time overlapping generation models without age-structure, occurs in the models considered here only when there is no upper age limit and when there is "sufficient" overlap of generations.

Events of 1977-78 in pictures:

Zyskind Lecturers:

C. R. Rao

Ingram Olkin

In the spring of '78, W. G. Cochran returned to ISU to give lectures and seminars.

Everyone enjoyed the alumni banquet. Pictured above are Winston Yang, James Chen, Wendell Ponder, Dr. David Harville, Kim Andriano, David Hasza, Bisu Bhattacharyay, and Irma Fernandez.

Dr. Lynn R. LaMotte shared office quarters and good times with graduate students Jerry Lewis, Ven-Shion Shu, and Richard Sedcole.

Dr. Tukey......

.....and his "students."

During the summer of '78, the resident Statistical Laboratory staff was supplemented by three visiting professors. Pictured above (front row) are: Dr. Kempthorne, Dr. Pollak, and Dr. James Cornette, visiting professor. In the back row; Dr. William Hill, visiting professor, Dr. Harville, and Dr. LaMotte, visiting associate professor.

During his trip to India, H. T. David visited with Ph.D. alum, Chaturvedula Asok.

*David, H. A. The theory of competing risks. *The Australian Journal of Statistics* 18:3 (November 1976) 101-114. SLRS 423.

The theory of competing risks is motivated, certain aspects are reviewed critically, and some extensions are indicated. A unified formulation of the theory is given covering dependent as well as independent risks. The relations between various functions useful in the theory are made explicit. In a historical note a valuable early result is put into modern notation. The currently controversial subject of identifiability when risks are dependent is discussed and it is indicated under what conditions some of the difficulties raised can be overcome. Consequences of assuming proportional hazard rates are set out. New conditions are provided under which this assumption holds and it is shown how the assumption may be tested. Some concluding remarks deal with limitations of the theory and point out areas needing further work.

David, H. A., W. J. Kennedy, and R. D. Knight (Texaco, Missouri City, Texas). Means, variances, and covariances of normal order statistics in the presence of an outlier. *Selected Tables in Mathematical Statistics* 5 (1977) 75-204.

Let $X_1,...,X_{n-1}$ be independent standard normal variates and Y a further independent variate representing the outlier. Tables of the means, variances, and covariances of the order statistics in the combined sample of size n are given for $n \leq 20$ in the following two cases:

(a) $Y \sim N(\lambda, 1)$ for $\lambda = 0(0.5)3,4$;
(b) $Y \sim N(0, \tau^2)$ for $\tau = 0.5, 2, 3, 4$.

For (b) additional values of the means and variances are provided for $\tau = 6, 8, 10$. Worked examples illustrate some uses of the tables in robustness studies.

*David, H. A. and V. S. Shu. Robustness of location estimators in the presence of an outlier. *Contributions to Survey Sampling and Applied Statistics:* 235-250. Academic Press. New York. 1978. SLRS 425.

The bias and mean square error of various location estimators, expressible as linear functions of order statistics, are studied when an unidentified single outlier is present in a sample of size n. Specific attention is paid to the cases when the outlier comes from a population differing from the target population either in location or scale. When, in addition, the target population is normal, exact numerical results have been obtained for n = 5, 10, 20 and are presented here for n = 10. The estimators included are the mean, median, trimmed means, Winsorized means, linearly weighted means, and Gastwirth mean.

David, H. T., Pamela Doctor, and Gabriela Stangenhaus. Two topics in optimum estimation. *Bulletin of the International Statistical Institute* 47:4 (1977) 673-680.

This paper indicates the nature of two recent investigations in optimum estimation. One of these, in the Cramer-Rao vein, shows that Holder's inequality provides as natural a link between a certain sort of generalized unbiasedness and a certain kurtosis-like measure of dispersion as it provides, in Barankin's modification of the standard Cramer-Rao argument, between ordinary unbiasedness and expected p-th power of deviation from expectation. The other investigation, in the Rao-Blackwell vein, exploits the fact that the sequential version of that methodology is as natural for general discrete-time zero-one exchangeable processes as it is for the independent Bernoulli process.

*Emigh, Ted H. Partition of phenotypic variance under unknown dependent association of genotypes and environment. *Biometrics* 33 (1977) 505-514. SLRS 422.

If genotypes and environments are independently associated, there is little conceptual problem in partitioning phenotypic variance into components due to genotypes and environments. However, no single partitioning of phenotypic variance has compelling force when environments and genotypes are not independently associated. A procedure called the analysis of commonality is applied to resolve the ambiguities in the analysis of variance.

The analysis of commonality is also applied to subdivided populations and to the partition of genotypic variance into additive and dominance components. The covariance between relatives with no common familial environment is given and it is found that the components of commonality, as well as heritability, cannot be estimated through covariances of relatives alone.

*Esimai, Grace O. and Chien-Pai Han. Double sampling in multi-auxiliary regression estimation based on conditional specification. *American Statistical Association: Proceedings of the Social Statistics Section 1977 Part II* 854-857. SLRS 431.

Consider a (p + 1) random vector $\binom{Y}{\underline{X}}$ which follows a multivariate normal distribution where Y is a scalar and $\underline{X}$ is a p x 1 vector ($p \geq 1$). In estimating the population mean μ_y of Y, it is well known that the precision of the estimator can be increased if auxiliary information is available. In this paper, we shall consider the linear regression estimator of μ_y with $\underline{X}$ as the auxiliary variable. To use the regression estimator we need to know the population mean μ_x of X. When μ_x is unknown, we may take a pre-

liminary sample to estimate it. This sampling procedure is the double sampling technique. In certain situations, an investigator may have partial information about μ_X and suspects that $\mu_X = \mu_0$. In order to utilize this partial information, the investigator can perform a preliminary test about the hypothesis

$$H_0 : \mu_X = \mu_0 \text{ versus } H_1 : \mu_X \neq \mu_0.$$

If H_0 is accepted, the investigator will use μ_0 in the regression estimator; otherwise he uses the sample mean based on the preliminary sample. This estimator is usually known as the preliminary test estimator. This paper derives the bias and mean square error of the preliminary test estimator. Relative efficiency of the estimator is studied. The optimal sample design is given.

*Fuller, Wayne A.** Some properties of a modification of the limited information estimator. *Econometrica* 45:4 (May, 1977) 939-953. SLRS 420.

Modifications of the limited information estimator and of the fixed k-class estimator that possess finite moments are presented. It is demonstrated that, through terms of $O(T^{-2})$, where T is the sample size, the fixed k-class estimator is dominated by the modification of the limited information estimator.

*Fuller, Wayne A.** and **J. J. Goebel.** On the estimation of season total number of different households utilizing a park. *Biometrics* 34 (1978) 139-141. SLRS 427.

A method for estimating the total number of households visiting a park is presented. The method, based upon procedures used in a study of Iowa parks, uses a sample of park visitors and end-of-season recall interview. The estimator and an unbiased estimator of variance are presented.

Fuller, Wayne A. and **Michael A. Hidiroglou.** Regression estimation after correcting for attenuation. *Journal of the American Statistical Association* 73:361 (1978) 99 - 104.

The limiting distribution of the regression coefficients calculated from a correlation matrix that has been corrected for attenuation is obtained. Methods of estimating the covariance matrix of the vector of regression coefficients are presented. Nonnormal regression variables and nondiagonal error matrices are considered. The procedures are illustrated with data on the socioeconomic career.

Gentle, James E. Testing for outliers in linear regression. *Contributions to Survey Sampling and Applied Statistics:* 223-233. Academic Press. New York. 1978.

The problem of outliers in the regression model is considered. For the case of one outlier at most, the use of the maximum absolute studentized residual, R_n, for identification of the outlier has been suggested by a number of authors. Simulation studies of the power of a conservative test based on R_n for identifying single outliers in regression models with one, two, and three independent variables are reported. The case of multiple outliers is also considered and techniques for their identification are discussed. A simulation study of a sequential procedure for handling two outliers is reported.

*Gentle, J. E., W. J. Kennedy,** and **V. A. Sposito.** On least absolute values estimation. *Communications in Statistics; Theory and Methods* A6:9 (1977) 839-845. SLRS 412.

The resistance of least absolute values (L_1) estimators to outliers and their robustness to heavy-tailed distributions make these estimators useful alternatives to the usual least squares estimators. The recent development of efficient algorithms for L_1 estimation in linear models has permitted their use in practical data analysis. Although in general the L_1 estimators are not unique, there are a number of properties they all share. The set of all L_1 estimators for a given model and data set can be characterized as the convex hull of some extreme estimators. Properties of the extreme estimators and of the L_1-estimate set are considered.

Ghosh, Malay and Nitis Mukhopadhyay. On two fundamental problems of sequential estimation. *Sankhya B* 38 (1976) 203-218.

This paper reviews and unifies the problems of bounded risk point estimation and bounded length interval estimation of the unknown normal mean with unknown variance. Multivariate generalizations of these results are also presented.

*Ghosh, Malay** and **Glen Meeden.** Admissibility of linear estimators in the one parameter exponential family. *The Annals of Statistics,* 5:4 (1977) 772-778. SLRS 402.

For estimating the mean in the one parameter exponential family with quadratic loss, Karlin (1958) gave sufficient conditions for admissibility of estimators of the form aX. Later, Ping (1964) and Gupta (1966) gave sufficient conditions for admissibility of estimators of the form aX + b for the same problem. Zidek (1970) gave sufficient conditions for the admissibility of X for estimating an arbitrary piecewise continuous function of the parameter, say $\gamma(\theta)$, not necessarily the mean. In this paper it is shown that Karlin's argument yields sufficient conditions for the admissibility of estimators of the form aX + b for estimating $\gamma(\theta)$. The results are then extended to the case when the parameter space is truncated.

Ghosh, Malay and P. K. Sen. Sequential rank tests for regression. *Sankhya A* 39 (1977) 45-62.

Asymptotic theory of sequential rank order tests (SROT) for the regression coefficient in a simple linear regression model is considered here. The proposed SROT terminates with probability one. For local alternatives, the OC function of the proposed SROT is the same as that of the Wald SPRT (sequential probability ratio test). Finally, the asymptotic ASN of the proposed SROT is compared with that of the SPRT.

Ghosh, Malay and David Sotres. Strong convergence of linear rank statistics for mixing processes. *Sankhya B* 39 (1977) 1 - 11.

Consider a double sequence of random variables $\{X_{ni}\}$ defined on some probability space (Ω, A, P). Based on these variables, we construct *signed linear* and *simple linear rank statistics*. If the random variables satisfy some mixing conditions, then strong convergence of such statistics to some suitable centering constant is proved. As a necessary tool, strong laws of large numbers for row means in a triangular array, and a Glivenko-Cantelli theorem are developed for mixing sequences of random variables.

*****Groeneveld, Richard A.** and **Glen Meeden.** The mode, median, and mean inequality. *The American Statistician* 31:3 (1977) 120-121. SLRS 406.

An elementary method of proof of the mode, median, and mean inequality is given for skewed, unimodal distributions of continuous random variables. A proof of the inequality for the gamma, F, and beta random variables is sketched.

Han, Chien-Pai. On the computation of noncentral chi-squared distribution. *Journal of Statistical Computation and Simulation* 6(1978) 207-210.

Let Y have the noncentral chi-squared distribution with v degrees of freedom and noncentrality parameter λ, and $F_v(y|\lambda)$ the cumulative distribution function. Han (1975, *Biometrika* 62, 213-214) has given the following relationships between noncentral chi-squared and normal distributions: (1) when $v = 1, F_1(y|\lambda) = \Phi(a) - \Phi(b)$, (2) When $v = 2k + 1$, $k = 1, 2, ..., \lambda > 0$,
$$F_v(y|\lambda) = F_1(y|\lambda) + \sum_{j=1}^{k} \binom{k}{j} 2^j F_1^{(j)}(y|\lambda)$$
where $a = \sqrt{\lambda} + \sqrt{y}, b = \sqrt{\lambda} - \sqrt{y}, F_1^{(j)}(y|\lambda)$ is the jth derivative of $F_1(y|\lambda)$ with respect to λ and $\Phi(\cdot)$ is the cumulative distribution function of the standard normal distribution. This paper derives a recursive formula for $F_1^{(j)}(y|\lambda)$ which can be easily programmed.

*****Han, Chien-Pai** and **T. A. Bancroft.** Estimating regression coefficients under conditional specification. *Communications in Statistics; Theory and Methods* A7(1), 1978, 47-56. SLRS 424.

A preliminary test estimator of regression coefficient is given when several regression lines may be parallel. Bias and mean square error of the preliminary test estimator are obtained and its relative efficiency to the never-pool estimator is studied. Recommendations of the significance levels of the preliminary tests are given. Similar procedures are indicated for intercepts.

Everson, L. E. and **D. K. Hotchkiss.** A comparison of the blowing and hand methods for the purity analysis of *Dactylis glomerata* seed. *Seed Science and Technology* 5:3 (1977) 451-462.

Reddy, K. V., A. A. Kraft, R. J. Hasiak, W. W. Marion, and **D. K. Hotchkiss.** Effect of spin chilling and freezing on bacteria on commercially processed turkeys. *Journal of Food Science* 43 (1978) 334-336.

A study was made of the effect of spin chilling and later freezing on possible spread of salmonellae and other bacteria on commercially processed turkeys in a federally inspected plant. Statistical analysis indicated that after spin chilling, levels of all organisms tested were reduced and no salmonellae were recovered. Coagulase positive staphylococci persisted on turkeys during processing and after freezing. Freezing caused further decreases in bacterial populations, but the spin chilling operation itself significantly reduced counts. No undue health hazard was observed from chilling procedures.

Huang, Cheng-Chi (Marshall University, Huntington, West Virginia) and **Dean Isaacson.** Ergodicity using mean visit times. *Journal-London Mathematical Society* 2:14 (1976) 570-576.

The finiteness of the mean visit time to state j is used in the characterization of uniform strong ergodicity for non-stationary Markov chains and weak ergodicity for stationary Markov chains. This clarifies a key difference between ergodicity and weak ergodicity for infinite stochastic matrices.

Kempthorne, Oscar. Comment on J. Kiefer's "Conditional confidence statements and confidence estimators." *The Journal of the American Statistical Association* 72:360 (1977) 816-819.

J. C. Kiefer, a leading proponent of the Neyman-Pearson-Wald (NPW) approach to statistical inference has, it appears, concluded that there are defects with NPW, though he does not make at all clear what these defects are. Apparently, they are related to the "practical man's feeling," whatever that is. An attempt was made by Kiefer to modify the approach, and the present paper is a discussion of the attempt. The thesis is advanced that Kiefer attempts to solve a problem he has not stated, and, furthermore, Kiefer still does not recognize the inherent failure of strict NPW theory with regard to logically quantifying the evidence given by the data. Kiefer's attempt to save

the theory is made by some sort of conditioning, but it would seem that no rationale is given for the choice of a conditioning rule. The present paper gives an assessment of the general status of the field and of the Kiefer attempt. It concludes that the attempt is a failure. It is appropriate here to suggest that the student should read the reply of Kiefer later in the journal. It would seem that this also evades the basic issues.

***Kempthorne, Oscar.** The International Conference on Quantitative Genetics: Introduction. *Proceedings of the International Conference on Quantitative Genetics:* 3-18. Iowa State University Press. 1977. SLRS 409.

This paper presents part of the background for the International Conference on Quantitative Genetics held at Iowa State University in August 1977. The origin of interest in the area at Iowa State is described briefly. An attempt is made to describe the relation of quantitative genetics to population genetics, in an effort to avoid widespread confusion that exists. The rationale behind the choice of sub-areas covered in the conference is presented.

***Kempthorne, Oscar.** Status of quantitative genetic theory. *Proceedings of the International Conference on Quantitative Genetics:* 719-760. Iowa State University Press. 1977. SLRS 411.

This paper attempts an overall analysis and critique of the field of quantitative genetics. The origins of the field are discussed briefly. The general logic of theory of covariances of relatives is given. Complications due to deviations from ideal assumptions are discussed. An evaluation of the utility of the "biometrical genetics" approach is made, this turning out to be negative. Elemental ideas of genetic selection theory, due in fact to Fisher, are given. The role of finiteness of populations is reviewed partially. Finally, the basic idea of theory of applied quantitative genetics, as used in animal breeding, for instance, is given in simple form. Prospects for the field are discussed.

***Kempthorne, Oscar.** Logical, epistemological and statistical aspects of nature-nurture data interpretation. *Biometrics* 34:1 (1978) 1 - 23. SLRS 429.

In this paper the nature of the reasoning processes applied to the nature-nurture question is discussed in general and with particular reference to mental and behavioral traits. The nature of data analysis and analysis of variance is discussed. Necessarily, the nature of causation is considered. The notion that mere data analysis can establish "real" causation is attacked. Logic of quantitative genetic theory is reviewed briefly. The idea that heritability is meaningful in the human mental and behavioral arena is attacked. The conclusion is that the heredity-IQ controversy has been a "tale full of sound and fury, signifying nothing." To suppose that one can establish effects of an intervention process when it does not occur in the data is plainly ludicrous. Mere observational studies can easily lead to stupidities, and it is suggested that this has happened in the heredity-IQ arena. The idea that there are racial-genetic differences in mental abilities and behavioral traits of humans is, at best, no more than idle speculation.

***Kempthorne, Oscar.** Some aspects of statistics, sampling, and randomization. *Contributions to Survey Sampling and Applied Statistics:* 11-28. Academic Press. New York. 1978. SLRS 426.

In this essay the general nature of conventional mathematical statistics is discussed. It is suggested that Neyman-Pearson-Wald decision theory is ineffective and that the making of terminal decisions must involve some sort of Bayesian process. Bayesian theory is, however, deficient with respect to obtaining of a prior distribution which seems to be a data analysis problem and to be the basic inference problem in a decision context. The relevance of parametric theory to the finite population inference problem is questioned. It is considered that intrinsic aspects of the logic of inference are given by the cases of populations of size one and two, and these are discussed. The role of labeling is considered and some work of Hartley and Rao discussed. It is suggested that there are difficulties in unequal probability sampling with respect to the ultimate inferences, that is, beyond the matters of estimation and variance of estimators. It is suggested that admissibility theory is ineffective. Absence of attention to pivotality is deplored.

***Kennedy, W. J., J. E. Gentle,** and **V. A. Sposito.** A computer oriented method for generating test problems for L_1 regression. *Communications in Statistics; Simulation and Computation* B6:1 (1977) 21-27 SLRS 418.

A numerical method for obtaining data $(X|\underline{y})$, relative to the linear model $\underline{y} = X\underline{\beta} + \underline{e}$, is given. The user is allowed to specify column means for the X matrix, the general order of condition number, the unique L_1 solution vector $\hat{\underline{\beta}}$ and the deviations of y's about the fitted hyperplane. Implementation of the

method requires little more than use of subroutines found in most modern subroutine libraries. Computer generated data of this kind are useful in numerical studies of the operating characteristics of different algorithms.

*Levikson, Benny (Purdue University, Lafayette, Indiana) and Zeev Schuss. Nonhomogeneous diffusion approximation to a genetic model. *Journal de Mathématiques Pures et Appliquées* 56 (1977) 55-65. SLRS 416.

Journal Paper J-8325, Iowa Agriculture and Home Economics Experiment Station, Project 1669; partial support by National Institutes of Health Grant GM-13827.

This paper deals with a fixed population of N individuals, having two haplotypes A and a. The population in each generation is generated in accordance with a generalized Wright-Fisher model, in which the selection intensity associated with type A varies with time. It is shown that the ultimate fixation of one or the other of the types is certain and the expected absorption time is finite. Asymptotic expansions are developed for fixation probabilities and the absorption time and their convergence is shown. The results are compared with those for the classical time-homogeneous case and for a special non-homogeneous case considered earlier by Kimura and Ohta. Numerical results for the probability of ultimate fixation of A and the expected absorption time are given for various situations in which the advantage of A, relative to a, changes with time.

*Meeden, Glen and Dean Isaacson. Approximate behavior of the posterior distribution for a large observation. *The Annals of Statistics* 5:5 (1977) 899-908. SLRS 415.

Let X be a real valued random variable with a family of possible distributions belonging to a one parameter exponential family with the natural parameter $\theta \epsilon (\theta, + \infty)$. Let g be a prior probability density for θ with unbounded support. Under some additional assumptions it is shown that for large values of x the posterior distribution of θ given X = x is approximately normally distributed about its mode. If δ_g denotes the Bayes estimator for squared error loss of some function $\gamma(\theta)$ against g then the rate at which $\delta_g(x)$ approaches infinity as x approaches infinity is found. The rate is shown to depend on the behavior of the prior density $g(\theta)$ for large values of θ.

*Meeker, William Q., Jr. Sequential tests of independence for 2 x 2 contingency tables. *Biometrika* 65:1 (1978) 85-90. SLRS 439.

This paper suggests a test for independence between to dichotomous characteristics when data are obtained sequentially. Truncated sequential test regions are found and the exact properties of the tests are evaluated. A numerical example is given and the test properties are compared with those of comparable fixed sample size tests.

Meeker, William Q., Jr. and G. J. Hahn. Asymptotically optimum over-stress tests to the estimate survival probability at a condition with a low expected failure probability. *Technometrics* 19:4 (November, 1977) 381-399.

This paper is concerned with the optimum allocation of test units to over-stress conditions when it is desired to estimate the survival probability at a design condition with a low expected failure probability. The criterion is that of minimizing the large sample variance; a logistic model is assumed. Expressions and charts for allocating test units to the accelerated stresses are provided and procedures for determining the stresses when these are not all specified are given. The gain in efficiency from using these plans versus testing exclusively at the design condition is analyzed. The requirement for some testing at the design stress and at an intermediate stress is also considered.

Meeker, William Q., Jr. and W. Nelson. Weibull variances and confidence limits by maximum likelihood for censored data. *Technometrics* 19:4 (November, 1977) 473-476.

This note presents a table of the large sample covariance matrix of the maximum likelihood estimates of parameters of a smallest extreme value distribution. The table can be used to obtain approximate large-sample confidence intervals when a Weibull (or smallest extreme value distribution) is fitted by maximum likelihood to singly censored data. Use of the table is illustrated with such data on the life of locomotive controls.

Meeker, William Q., Jr. and Wayne Nelson. Maximum likelihood theory for optimum accelerated life tests for Weibull and extreme value distributions. *Technometrics* 20:2 (May, 1978) 171-177.

This paper presents theory for optimum accelerated life test plans for estimating a simple linear relationship between an accelerating stress variable and product life, which has a Weibull or smallest extreme value distribution, when the data are to be analyzed before all tests units fail. The plans show that one need not run all test units to failure and that more units should be tested at low test stresses than at high ones. The plans are illustrated with a voltage-accelerated life test of an electrical insulating fluid.

Hahn, G. J., P. I. Feder, and W. Q. Meeker. Evaluating the effect of incorrect specification of a regression model, part 1. Basic concepts and example. *Journal of Quality Technology* 10:2 (April, 1978) 61-72.

Designed experiments are frequently used in industry to identify those process variables that most strongly affect product quantity and quality. Hahn, Meeker, and Feder (*Journal of Quality Technology*, Vol. 8, No. 3, July 1976) demonstrated that it is possi-

ble to learn many things about the adequacy of a proposed experimental plan *before* any data are collected.

One important part of designing an experiment is to specify a statistical model to relate the observed response (e.g., yield of acceptable product) to the design variables (e.g., temperature, pressure, amount of catalyst). The data from the experiment are then used to estimate the coefficients of the assumed model and to estimate mean responses by least squares regression analysis. In the previous paper, it was assumed that the statistical model is specified correctly. In this paper, evaluation of the consequences of making incorrect assumptions about the form of the model is described and illustrated with the help of a new computer program, EXPLOR II.

*Pollak, Edward. Selective advance in populations with overlapping generations. *Proceedings of the International Conference on Quantitative Genetics:* 379-397. Iowa State University Press. 1977. SLRS 410.

The author considers an infinite diploid population, measured at times 0, 1, 2, ..., in which there are h age groups among males and k age groups among females. In addition, there is a possible division of each of the h + k age-sex classes into two types; individuals used to breed male offspring and individuals used to breed female offspring. It is assumed that, once an individual is chosen to breed a particular sex of offspring, it is used in that way throughout the remainder of its reproductive life.

It is assumed that, initially, there is random mating, with no linkage disequilibrium, and that there is then weak selection applied only once, at time 0. The difference between the mean of individuals of age-sex class j that were saved to breed sex v progeny and the mean of all individuals of the same age-sex class is called the selection differential associated with this age-sex class. It is denoted by $I_{j,v}$.

The selective advance, or response, of individuals of age-sex class i' at time t is equal to the predicted mean of such individuals minus the mean of individuals of this age-sex class in the original population. This is denoted by $r_{i'}(t)$.

The view is taken that, if a descendant and an ancestor are observed at different ages, the character in the descendant is different from the character in the ancestor. A general expression is given for the covariance between a random pair of relatives with a certain pattern of relationship, if one is measured in attribute X and the other in attribute Y. This expression is used in constructing linear prediction equations for the $r_{i'}(t)$ in terms of given values of the $I_{j,v}$. Expressions for the limiting responses $r_{i'} = \lim_{t \to \infty} r_{i'}(t)$ are then derived, and these turn out not necessarily to be the same for all values of i'. There is a discussion of the relationship of these results to others in the literature.

*Roux, C. Z. (Animal and Dairy Science Research Institute, Pretoria, South Africa). Fecundity differences between mating pairs for a single autosomal locus, sex differences in viability and nonoverlapping generations. *Theoretical Population Biology* 12:1 (1977) 1-9. SLRS 413.

Recurrence equations are derived for the change in genotype frequencies for general fecundity functions. Statistical models that will result in fecundity functions factorable into male and female contributions are developed. Some attention is given to the genetic structure and equilibrium behavior of single-locus genetic systems with additive fecundities.

*Sedcole, J. R. Number of plants necessary to recover a trait. *Crop Science* 17 (1977) 667-668. SLRS 414.

Four methods are presented for calculating the number of plants needed, with a specified high probability, to recover a given number of plants possessing a trait, given that the trait occurs with a known probability.

Sposito, V. A., M. L. Hand and **G. F. McCormick.** Using an approximate L_1 estimator. *Communications in Statistics; Simulation and Computation* B6:3(1977) 263-268.

This paper investigates the efficiency of using near-best or approximate L_1 estimators as starting values in L_1 linear programming procedures. In particular, it is shown that the total computer time can be reduced if one first computes the least squares estimator, $\hat{\beta}$, and then adjusts y to y - X$\hat{\beta}$ in Barrodale and Roberts' improved algorithm.

Strahan, R. F. Letter to the editor. *Psychophysiology* 14 (1977) 420-421.

A criticism (with editorial reply) to this journal's statistical policy, which was seen as inappropriately restrictive.

Strahan, R. F. On the Nihmian way. *American Psychologist* 32 (1977) 383-384.

A tongue-in-cheek response to a spoof, with allusions to Immanuel Kant, Isaac Newton, and General John Pershing. The serious issue is the use of statistical models to reflect (psychological) reality.

Strahan, R. F., M. K. Hill and M. K. Mount. Site differences in electrolyte concentration assessed by the water bottle sweat measure. *Psychophysiology* 14 (1977) 609-612.

Electrolyte concentration of sweat as a function of sampling site was assessed by the water bottle technique in 36 female and 36 male, right-handed college students. Sweat samples were taken under resting conditions from the five finger tips and the palm of both hands. Electrolyte concentration was lower at the palm than at the fingers, among which concentrations were not appreciably different. There was no evidence of different electrolyte concentrations between matching sites on the left and right hands, nor were sex differences in concentration observed. Because the fingers seem to be similar in electrolyte concentration, they might be used interchangeably in group studies involving multiple water bottle sweat samplings.

*Sukhatme, B. V. and Lal Chand. Multivariate ratio type estimators. *1977 Social Statistics Section Proceedings of the American Statistical Association* 927-931. SLRS 432.

It is well known that the ratio estimator $T_1 = (\bar{x}_{0n_0} \bar{X}_1)/\bar{x}_{1n_0}$ of the population mean $\bar{X}_0$ of a finite population of size N is more efficient than the simple mean $\bar{x}_{0n_0}$ if $2\rho_{x_0 x_1} > CV(x_1)/CV(x_0)$. If $\bar{X}_1$ is not known but $\bar{X}_2$ the population mean of another variate x_2 correlated with x_0 such that $\rho_{x_0 x_2} < \rho_{x_0 x_1}$ is known, it is shown that the ratio estimator

$$T_2 = (\bar{x}_{0n_0} \bar{x}_{1n_1} \bar{X}_2)/(\bar{x}_{1n_0} \bar{x}_{2n_1})$$

with $n_1 > n_0$ is more efficient than T_1 if $2\rho_{x_0 x_2} > CV(x_2)/CV(x_0)$. The paper presents the bias and mean square error of the esimator T_2 and generalizes the results to several auxiliary variables.

Mulford, Charles L., Gerald E. Klonglan, **Richard D. Warren,** and Janet B. Padgett. A multidimensional evaluation of effectiveness in a non-economic organization. *Organization and Administrative Sciences* 7:4 (1977) 125-143.

The purpose of this research was to investigate the relative utility of a multidimensional analysis of the effectiveness of local disaster preparedness organizations. The results indicate that six different measures of effectiveness utilized are significantly intercorrelated. Likewise, all measures of effectiveness are significantly correlated with measuring processes of communication, socialization and recruitment selectivity as hypothesized by Etzioni.

*Wolins, Leroy. Interval measurement: physics, psychophysics, and metaphysics. *Educational and Psychological Measurement* 38 (1978) 1-10. SLRS 437.

The meaning of interval measurement in physics stems from well supported theory which specifies the procedures for making measurements and provides the explicit functional relationship between variables derived from different measurement procedures. The concept of interval measurement may be heuristic but in applied fields of psychology and education it is not scientifically relevant because theory is inadequate to either specify how to obtain measurements or to specify the function which relates different measures.

Wolins, Leroy. Sex differentials in salaries: faults in analysis of covariance (a letter to the editor). *Science* 206: 4343 (19 May 1978) 723.

Whitmer, J. M., Jr., **Leroy Wolins,** and Lynn Hart. Profiles of faculty collective bargaining at the University of Northern Iowa, Iowa State University, and the State University of Iowa. *Iowa State Journal of Research* 52:1 (1977) 67-97.

Dissertation Abstracts

Carvalho, Jose Ferreira de. Data analysis of multiway tables. Ph.D. thesis, Iowa State University Library, August, 1977.

Cross-classified sets of data are often reduced by means of additive models. In many instances, however, additive models are inadequate. When this is the case, some useful representation of the data may be possible by fitting a model to the interaction components.

A model, which assumes that the factors effects are separable, is proposed to represent the interactions. This was considered by Mandel (1969) and by Gollob (1968) for the two-factor case and is here extended to multiway situations.

The proposed model is multilinear and so multilinear algebra is used extensively in the development. In particular the least squares approximation of a tensor by a decomposable tensor is considered. The solution is characterized and an iterative numerical procedure is presented for the actual calculation. An analysis of variance is developed for these multilinear components.

Chen, Jengrong James. Testing for outliers in linear models. Ph.D. thesis, Iowa State University Library, February, 1978.

The problem of outlier detection in linear models is considered. When data are suspected to contain one outlier; the use of the maximum-absolute studentized residual for outlier identification is suggested. Some approximate measures of the performance of procedures based on its uses are discussed. The performance of the test depends on the position of the outlier in relation to the design matrix. Additional problems arise when data contain more than one outlier. A valid datum can appear as an outlier under the single outlier testing procedure.

Next, when data are suspected to contain exactly two outliers, a two-outlier testing procedure is given. An example is provided to illustrate the use and some properties of the procedure. The performance of the test is considered, and for the special case of two-way layouts, tables of probability detection for two outliers are given.

The presence of more than one outlier can lead to difficulties in the identification of any of the wild data. The problems are caused by inflation of the variance estimator or by bias in the location estimators. In the regression model, the position of outliers in relation to the pattern of the design matrix gives rise to further complications in the detection of the outliers. A backward deletion procedure for detecting multiple outliers is suggested. An outlier resistant regression procedure is used to identify a set of observations that is likely to contain outliers. Least squares methods are then employed to identify the specific observations to be considered outliers. To illustrate the use of the procedure, a well-known example in the outlier problem is considered. A Monte Carlo study for the performance of the procedure is reported.

Finally, the problem of the effects of outliers on inferences is studied. The parameter estimates and predicted values from a least squares fit are biased, when outliers are present. The bias depends on the position of the outlier in the design matrix. Moreover, it shows that for a small amount of deviation of the outlying observation the estimation and prediction based on the full data set may be better in mean square error than that based on the reduced data set.

Galmes, Miguel Angel. Sampling design for the crop survey in Uruguay. M.S. thesis, Iowa State University Library, November, 1977.

A two-stage sampling design with stratification at each stage is studied. The variance of some estimators and estimates of those variances are derived. Both a random and a systematic selection of the sample are considered and the optimal allocation of the sample is obtained. Since 1974 this design has been used in a crop survey in Uruguay. The development is illustrated with data from the first crop survey in Uruguay, and some problems for applying the previous theory are discussed.

Hasza, David. Estimation in nonstationary time series. Ph.D. thesis, Iowa State University Library, August, 1977.

Define the autoregressive time series

$$\{Y_t : t \in (1,2,...)\} \text{ by } Y_t = \sum_{j=1}^{p} a_j Y_{t-j} + e_t$$

where $\{e_t : t \in (1,2,...)\}$ is a sequence of independent $(0, \sigma^2)$ random variables and $(Y_{-p+1}, Y_{-p+2}, ..., Y_0)$ is an initial vector of fixed constants. Associated with the process $\{Y_t\}$ is the characteristic equation

$$m^p - \sum_{j=1}^{p} a_j m^{p-j} = 0.$$

The roots $m_1, m_2, ..., m_p$ are termed the characteristic roots of the process Y_t. In the following it is assumed, for convenience, that $|m_1| \geq |m_2| \geq ... \geq |m_p|$. If $|m_1| < 1$ the process converges to a stationary time series as $t \to \infty$. If $|m_1| = 1$ the process is called "mildly explosive," and the variance increases as a polynomial in t as $t \to \infty$. If $|m_1| > 1$ the process is called "explosive," and the variance increases exponentially as $t \to \infty$.

The least squares estimator of $\underset{\sim}{a} = (a_1, a_2, ..., a_p)'$ is investigated. This estimator $\underset{\sim}{a}$ is denoted by $\hat{\underset{\sim}{a}} = (\hat{a}_1, \hat{a}_2, ..., \hat{a}_p)'$ and is obtained from the regression of Y_t on $Y_{t-1}, Y_{t-2}, ..., Y_{t-p}$ for $t = 1, 2, ..., n$. Under the additional assumption that the e_t are normally distributed, $\hat{\underset{\sim}{a}}$ is the maximum likelihood estimator of $\underset{\sim}{a}$. The regression estimator of σ^2 and the regression 'F-statistics' for testing linear hypotheses about $\underset{\sim}{a}$ are also investigated. Particular attention is given to processes with $|m_1| > 1$ and to processes with $m_1 = m_2 = ... = m_q = 1$.

Processes which contain a deterministic nonstationary component in the form of a time trend are investigated. Hypothesis testing and forecasting procedures are considered. For the pth order autoregressive process with two characteristic roots equal to one, the limiting distribution for $\hat{\underset{\sim}{a}}$ is characterized in a form which allows simulation. The distributions of $\hat{\underset{\sim}{a}}$ and of likelihood ratio tests for certain hypothesized parameter configurations are investigated via the Monte Carlo method.

Huang, Cheng-Chi. Non-homogeneous Markov chains and their applications. Ph.D. thesis, Iowa State University Library, August, 1977.

Let $\{X_n\}_{n=1}^{\infty}$ be a non-homogeneous Markov chain with transition matrices $\{P_n\}_{n=1}^{\infty}$. Assume that P_n converges to a stochastic matrix P and that P is strongly ergodic (that is, P^n converges to a row-constant stochastic matrix Q). It is known that in this case the product $P_{m+1}P_{m+2}...P_{m+n}$ converges uniformly in m to the row-constant matrix Q. In Chapter II we determine the rate of convergence of the produce $P_{m+1}P_{m+2}...P_{m+n}$ to Q in terms of the rate of convergence of P_n to P.

In Chapter III the finiteness of the mean visit time to state j is used in the characterization of uniform strong ergodicity for non-homogeneous Markov chains and weak ergodicity for homogeneous Markov chains.

In Chapter IV the concepts of scalar and diagonal normalization are applied to finite non-homogeneous Markov chains with at least one absorbing state. Some practical uses of such modified chains are explored.

Huang, Elizabeth Ti-jan Hsu. Nonnegative regression estimation for sample survey data. Ph.D. thesis, Iowa State University Library, February, 1978.

The regression estimation in a sample survey when data are available from outside sources for several characteristics of the population is considered. The estimation of cell probabilities in a two-way table where the marginal probabilities are known is a special case. The generalized regression estimator and the maximum likelihood estimator are both best asymptotically normal estimators for the multinomial frequencies

A computer algorithm is designed to provide non-negative weights w_i for a regression-type estimator of the form $\sum_i w_i y_i$. For the estimation of a cell mean (or total) in the multi-way table problem, the algorithm will give nonnegative cell means (or totals) with the estimated marginals equal to the known marginals. The computer algorithm is flexible enough to handle all of the common survey designs. Under simple random sampling, the regression estimator with nonnegative weights has the same large sample properties as the usual regression estimator. Consistent variance estimators based on the jackknife technique and on the Taylor approximation are suggested. The regression procedures are illustrated using data collected in the 1967 National Inventory of Soil and Water Conservation Needs.

Stangenhaus, Gabriela. Optimum estimation under generalized unbiasedness. Ph.D. thesis, Iowa State University Library, August, 1977.

Consider a family of densities $\{f(x; \theta), \theta \epsilon \Theta\}$, Θ ϵ R an open interval, and let $\underline{X} = (X_1, ..., X_n)$ be a corresponding sample of size n. For $\gamma > 1$ and $\delta(\underline{X})$ a statistic such that $E|\delta(\underline{X})|^\gamma < \infty$, $\theta \epsilon \Theta$, define $h_\gamma(u, \theta)$ $\equiv E|\delta(\underline{X}) - u|^\gamma$. Then h has a unique minimum $m_\gamma(\theta)$ in u, and, in keeping with Lehmann (1951), δ is defined to be γ-unbiased for $m_\gamma(\theta)$. Under suitable regularity conditions

$$K_\gamma(\delta, m) \equiv \{E|\delta(\underline{X}) - m_\gamma(\theta)|^\gamma\}^{\frac{\gamma-1}{\gamma}} / (\gamma-1) E|\delta(\underline{X}) - m_\gamma(\theta)|^{\gamma-2}$$

$$\leq |m_\gamma(\theta)| / \{E[|\partial/\partial\theta \log \underline{f}(\underline{X}; \theta)|^\gamma]\}^{1/\gamma},$$

when δ is γ-unbiased for $m_\gamma(\theta)$. This bound is achieved by the normal distribution. For $\gamma = 2m$ an asymptotic bound is obtained and achievability in an asymptotic sense is obtained for the exponential family. When $\gamma = 1$, if the density g_θ of $\delta(\underline{X})$ has a unique median $m(\theta)$ and is continuous at $m(\theta)$ and $m'(\theta)$ exists, then $K_1(\delta, m) \equiv 1/[2g(m(\theta); \theta)] \geq |m'(\theta)|/ E[|\partial/\partial\theta \log \underline{f}(\underline{X};\theta)|]$, with $K_1(\delta, m)$ the formal limit of $K_\gamma(\delta, m)$. $K_1(\delta, m)$ has appeared in Alamo (1964), in connection with a weaker bound.

Tu, Ching-tsao. Discriminant analysis based on binary and continuous variables. Ph.D. thesis, Iowa State University Library, May, 1978.

An observation $\underline{W} = \binom{X}{\underline{Y}}$, where X is a univariate Bernoulli variable and $\underline{Y}$ is a p-variate continuous vector, is to be classified into one of two populations. Based on the point biserial model (Olkin and Tate, 1961, Annals of Mathematical Statistics, 32, 448-465). Chang and Afifi (1974, JASA, 69, 336-339) proposed a double discriminant function (DDF) procedure. They studied the behavior of the DDF under the assumption that all parameters are known. When the parameters are unknown or partially known, sample DDF's are obtained by replacing the unknown parameters by their sample estimates. A sampling scheme referred to as the double inverse sampling is proposed to insure nonsingularity of the sample covariance matrices. Asymptotic distributions of the sample DDF's are derived under the double inverse sampling scheme. Comparisons of three classification procedures, namely DDF, X-out, (the discrete variable X is completely left out) and X-continuous (the discrete variable is treated as if it were continuous) procedures, are made.

A Memorable Three Weeks with W. G. Cochran

During a three-week stay with the department, W. G. Cochran, professor emeritus of statistics at Harvard University and a member of the National Academy of Sciences, presented a series of five lectures on observational studies and three seminars (listed elsewhere in this issue). His presentations were well-attended by the department's faculty and students and others from different departments. The lectures and two seminars were audio-taped and the other seminar was color videotaped for future use by the department.

Dr. Cochran was a professor of mathematical statistics in the Statistical Laboratory from 1939-1946. A banquet was held on April 5 in honor of his brief return to ISU.

Dr. Cochran made the following comments about how the department has changed since he was a professor here:

When the first Ph.D. in mathematical statistics was awarded to Holly Fryer in 1940, there was no department of statistics, the degree coming under the wing of the mathematics department. For direction of the early Ph.D. program, there were 3 professors with only a trickle of graduate students. Currently, as I count it, the department has 17 professors working with 98 graduate students. It has always been one of the main sources, perhaps *the* main source, of highly trained young statisticians in the country.

Department of Statistics

Course work in the Department of Statistics can culminate with a B.S., M.S., or Ph.D. degree in Statistics through the College of Sciences and Humanities. A specialized biometry program of study can lead to a B.S. degree conferred by the College of Agriculture.

The undergraduate statistics majors are prepared through a combination of theory and application courses for employment in industry or government or to pursue graduate studies.

Graduate students may specialize in experimental design, general methods, general theory, probability, statistical computing, survey sampling, or one of several areas of application. Operations research is offered cooperatively with the Department of Industrial Engineering.

A student may receive a graduate or undergraduate degree jointly with another department. An M.S. candidate may elect a thesis or nonthesis option. The latter requires six additional credits including a "creative component" of at least three credits of individual work.

Enrollments of majors as well as overall class enrollments are continuing to grow at both the undergraduate and graduate levels. Standards of admission for graduate majors have been raised in an attempt to slow down further growth in graduate numbers.

An expanded core program in statistical methods for graduate students was introduced this year. Increased emphasis has been placed on the uses of the computer and computer terminals.

During the year undergraudate enrollment in statistics climbed to 32 in comparison to 20 for the same time period last year. Seven of the 32 have joint majors. Five students are enrolled in biometry.

A successful 5-week NSF supported Summer Science Training Program for high school students was held during June and July. The program, directed by R. A. Groeneveld, included instruction in probability, statistics, and computing. Participating students came from as far away as California, but mostly from Iowa and adjoining midwestern states. All but one of the 28 participants had just completed the junior year of high school, and 12 will be freshmen in Statistics and other departments at ISU in the fall, 1978.

A new course, Statistics 451X, Applied Time Series was offered during the spring quarter. The course was taught by William Meeker. Some of the topics were 1) multiple regression with time series data, 2) methods of smoothing, decomposition, and seasonal adjustment of time series data, and 3) identification, fitting, and checking of regular and seasonal autoregressive-moving average models.

William Kennedy taught Statistics 579X, a one-credit course. Material covered included remote computer terminals, job control languages, etc., and exercises were given on these subjects.

Kenneth Koehler taught Statistics 501 this spring. Material covered included an introduction to the analysis of variance with unequal subclass numbers; an introduction to the analysis of categorical data analysis including log-linear models; methods of simultaneous inference; and continous multivariate methods including Hotelling's T^2, principal components, and linear discriminant function. Current computer software, mainly SAS, was utilized in data analyses.

1977-78 Course Offerings in Statistics

Courses for Undergraduate Students Only

100	Orientation in Statistics	R	F	Groeneveld
101	Principles of Statistics	5	F,W,S	Castonguay Groeneveld Lin Mee Midha Sallas Scott
104	Introduction to Statistics	5	W,S,SSI	Auer J. David Ferree Hotchkiss Kivior Mowers Rangachari Scott S. Sukhatme
105	Introduction to Statistics	3	F,S	Ferree Huntsberger Meeden Protz S. Sukhatme Van Nostrand

127	Elementary Business Statistics	5	F,W,S	Der Kackar Lin Meeker Midha Shu Tu
305	Engineering Statistics	3	S	Van Nostrand
327	Elementary Business Statistics	4	F,W,S	David Der Groeneveld Meeker
331	Probability for Engineers	3	F	Van Nostrand
332	Statistical Inference for Engineering Data	3	W	Van Nostrand
341	Introduction to Theory of Probability and Statistics	3	F,W	Groeneveld Huntsberger Meeden
342	Introduction to Theory of Probability and Statistics	3	W,S	Groeneveld Huntsberger
343	Introduction to Theory of Probability and Statistics	3	S	Huntsberger
380	Statistical Applications of Digital Computers	3	F,S	Bubolz

Courses for Graduate Minors and Undergraduates

401	Statistical Methods for Research Workers	4	SSII,F, W,SSI	Bailey Bixenstine C. P. Cox D. Cox Gentle Groeneveld Hickman Hinz Hotchkiss Koehler Strahan Warren
402	Statistical Methods for Research Workers	4	SSII W,S	Bailey Bixenstine D. Cox Han Hickman Hotchkiss Koehler Strahan Warren
407	Methods of Multivariate Analysis	3	F	Wolins
411	Experimental Design for Research Workers	3	S,SSI	D. Cox Gentle Harville Hotchkiss Strahan
421	Survey Designs for Research Workers	4	SSII,S	B. Sukhatme
422	Survey Sampling for Social Scientists	4	W	Baker
432	Applied Probability Models	3	W	Groeneveld
436	Genetic Statistics for Research Workers	3	F	Bailey
446	Statistical Theory for Research Workers	3	F	Huntsberger
447	Statistical Theory for Research Workers	3	W,SSI	Han Scott
448	Statistical Theory for Research Workers	3	SSII,S	Han Huntsberger
481	Computer Processing of Statistical Data	3	W	Gentle
490H	Special Topics (Honors)	ARR	W	Meeker

Courses Primarily for Graduate Students, Major or Minor

500	Statistical Methods	4	W	Harville
501	Intermediate Statistical Methods	3	S	Koehler
504	Linear Composites	3	S	Wolins
508	Sociometric Statistics	3	F	Warren
511	Design of Experiments	3	S	Kempthorne
512	Design of Experiments	3	F	Kempthorne
521	Design of Surveys	3	W	Goebel
522	Design of Surveys	3	S	Goebel
533	Industrial Statistics: Realiability	3	F	H. T. David
535	Biological Statistics	3	S	C. P. Cox
536	Genetic Statistics	3	F	Pollak
537	Genetic Statistics	3	W	Pollak
538	Econometric Statistics	3	F	Fuller
539	Operations Research	3	W	H. T. David
540	Operations Research Methods and Economic Analysis	3	SSI	Sposito
541	Theory of Probability and Statistics	3	F	Arnold
542	Theory of Probability and Statistics	3	W	Meeden
543	Theory of Probability and Statistics	3	S	Ghosh
544	Statistical Decision Theory	3	S	H. T. David
546	Nonparametric Theory	3	S	S. Sukhatme
549	Mathematical Programming	3	S	Sposito
559	Advanced Econometric Statistics	3	W	Fuller
580	Statistical Computations on Digital Computers I	3	F	Gentle
581	Statistical Computations on Digital Computers II	3	W	Kennedy
590	Special Topics	ARR	SSII,F,W S,SSI	Arnold C. P. Cox D. Cox Fuller Gentle Goebel Han Hotchkiss Isaacson Kempthorne Kennedy Meeker Pollak Sposito B. Sukhatme Warren Wolins

601	Advanced Statistical Methods	3	F	C. P. Cox
621	Advanced Survey Design	3	W	B. Sukhatme
622	Survey Design Seminar	3	S	B. Sukhatme
641	General Theory of Linear Hypothesis	3	F	Harville
642	Probability and Distribution	3	W	Isaacson
643	Testing Hypotheses	3	S	Meeden
645	Order Statistics	3	W	H. A. David
647	Multivariate Analysis	3	F	Han
648	Seminar on the Theory of Statistics and Probability: Ranking Theory	1	SSII	Conover
648	Seminar on the Theory of Statistics and Probability: Bayesian Inference	3	SSI	Meeden
661	Theories of Inference	3	SSI	Kempthorne
680	Seminar on Statistical Computations	3	F	Kennedy Sposito
699	Research	ARR		Arnold Harville Isaacson Kempthorne Pollak Sposito B. Sukhatme C. P. Cox H. A. David H. T. David Fuller Gentle Han

Graduate Students

Seven Ph.D. degrees and sixteen M.S. degrees were earned by students in the Department this fiscal year. Abstracts of the Ph.D. dissertations and of one M.S. thesis written in partial fulfillment of the graduation requirements appear in the publication section. Fifteen of the M.S. degrees were conferred on a non-thesis basis. If educational or employment plans are known, a brief account is given for each student.

M. S. Recipients

Promod Kumar Chandhok (Spring, 1978, under Wayne A. Fuller) is working towards a Ph.D. in the Department. Sampling and time series are his areas of concentration.

Shen-Lan Chang (Spring, 1978, under Don Hotchkiss) will seek employment in Oregon where her husband has accepted a position.

Paul Frederick Dahm (Summer, 1977, under Wayne A. Fuller) is continuing in his graduate studies in the Department. His areas of concentration include econometrics, time series, and errors in variables.

Jeffrey Lynn David (Winter 1978, under William J. Kennedy) is a statistical consultant in the analytic support center of American Telephone and Telegraph, Basking Ridge, New Jersey.

Mohamad Ervin (Summer, 1977, under Roy Hickman) has returned to Indonesia to work for the Central Bureau of Statistics in Jakarta.

Miguel Angel Galmes (Fall, 1977, under Chien-Pai Han) has returned to his position as a senior research officer in the statistical branch of the Ministry of Agriculture and Fisheries, Montevideo, Uruguay. His major responsibility is the design of sample surveys.

Wen Tai Hsieh (Summer, 1977, under Don Hotchkiss) is a statistical consultant in the agronomy department at the University of Illinois, Urbana.

Shun-hsia Hsu (Summer, 1977, under William J. Kennedy) has returned to her native country, Taiwan.

Steven Robert Johnson (Fall, 1977, under D. F. Cox) is employed at Sundstrand in Ames as a market research analyst. His job duties include forecasting economic trends and future demand for Sundstrand products.

Siamak Noorbaloochi (Spring, 1978, under Barry Arnold) remains in the Department working towards a Ph.D. under Glen Meeden. Statistical inference is his area of interest.

Sunday Johnson Osho (Fall, 1977, under C. P. Cox) is undergoing in-service-training as a research officer with the Federal Ministry of Agriculture and Natural Resources in the Department of Agricultural Research, Ibadan, Nigeria.

Don Penner (Spring 1978, under William J. Kennedy) is a statistical analyst for Goodrich in Orange, Texas.

Debra Lee Shenk (Summer, 1977, under H. T. David) continues her studies working towards a Ph.D. degree under Paul Hinz and Barry Arnold. Statistical methods is her area of interest.

Kent R. Skalland (Summer 1977, under William Q. Meeker, Jr.) is a systems application coordinator at Farmland Industries, Incorporated, Kansas City, Missouri. His duties include statistical computing.

Shirley Bok Park Sung (Fall, 1977, under Roy Hickman) remains in Ames while her husband is completing a Ph.D. in Industrial Engineering.

Young Kyun You (Fall, 1977, under B. V. Sukhatme) returned to his position as a Lt. Colonel in the Korean Military Academy, Seoul, South Korea, where he is teaching mathematics.

Ph.D. Recipients

José Ferreira de Carvalho (Summer, 1977, under Oscar Kempthorne) is teaching graduate and undergraduate courses in the Department of Computer Science and Statistics at the University of Sao Paulo, Sao Carlos, Brazil.

Jengrong James Chen (Winter, 1978, under James E. Gentle) is a project analyst in the Iowa Testing Programs, University of Iowa. His major responsibility is the development of a computer-assisted data analysis (CADA) system for Bayesian statistics. Chen is working on Bayesian analysis in linear models.

David Paul Hasza (Summer, 1977, under Wayne Fuller) is an assistant professor in the Department of Statistics at Kansas State University, Manhattan, Kansas.

Cheng-Chi Huang (Summer, 1977, under Bernard Vinograde and Dean Isaacson) is an assistant professor of mathematics at Marshall University, Huntington, West Virginia.

Elizabeth Ti-Jan Hsu Huang (Winter, 1978, under Wayne A. Fuller) is a statistician in the Statistical Research Division of the Bureau of the Census in Washington, D. C. Her major responsibilities are research and consulting in the area of sampling theory and statistical methods.

Gabriela Stangenhaus (Summer, 1977, under H. T. David) is teaching graduate and undergraduate courses in the Department of Computer Science and Statistics at the University of Sao Paulo, Sao Carlos, Brazil.

Ching-tsao Tu (Spring, 1978, under Chien-Pai Han) is employed as a senior statistician for American Cyanamid Company, Princeton, New Jersey. His major responsibility lies with data analysis and statistical consultation.

M.S. Candidates

Abdel-Megeed, Samir	Lo-Utai, Sue
Al-Fozan, Abdulrahman	Mee, Robert
Anselmi, Luis	Megahed, Abdel
Beck, Marvin	Mei, Maria
Bondy, Eric	Niknian, Minoo
Carvavattana, Rattana	Noma, Akihiro
Castonguay, Joy	Noorbaloochi, Siamak
Chandhok, Promod	Osho, Johnson
Chang, Shen-Lan Chu	Palmer, Joan
Chavez-Guerrero, Shirley	Penner, Don
Chen, Jiunn-Charn	Pongsrihadulchai, Apichart
Chiyenda, Simeon	Prebihalo, John
David, Jeffrey	Protz, Steven
Dehghan-Nayeri, Majid	Razmpour, Ahmad
Der, William	Ridpath, Harold
Egbon, Michael	Saad-Eldin, Mohamed
Enger, Cheryl	Sakia, Remi
Ervan, Mohamad	Seyedsadr, Seyed Mahmoud
Fakiya, James O.	Shen, Arn-Shi
Galmes, Miguel Angel	Sivira, Jose
Guerrero, Margarita	Skalland, Kent
Herrera-Haro, Jose	Slamet
Hong, Emile	Skarpness, Bradley
Hsieh, Wen Tai	Steiner, Michael
Hsu, Sheue Wen	Sung, Bok Park
Hsu, Shun-Hsia (Dorothy)	Tan, Hsien-Hui
Huang, Michael	Wang, Bei-Li
Ihnen, Leigh	Werner, Neil
Jan, Yih Ming	Wu, Amy Tei-Mei
Johnson, Steven	Yen, Shu-Mien
Kaluzny, Stephen	Yergler, Dennis
Kim, Byung Hwee	Yih, Wei
Kivior, Susan	You, Young-Kyun
Kuo, Tsuey Lin	Yu, Fu-hau
Lewis, Jerry	Zaher, Adel
Liberty, T. Edward	

Ph.D. Candidates

Andriano, Kim	Kackar, Raghunath
Auer, Richard	Kim, Geung Ho
Aziz, Mohammad	(joint industrial engineering-
(joint sociology-statistics)	statistics)
Bhattacharyay, Biswanath	Lamyordmakpol, Anuchit
Biyani, Shriram	Lee, Edward Henry
Chen, Jengrong James	
Crouse, Ken	Lin, Cherng-Tarng
(joint computer science-	Londhe, Anil
statistics)	Mellon, James
Dahm, P. Fred	Midha, Chand
Da Silva, Antonio	Mo, Wing-Hung
Ebrahimi, Nader	(joint industrial engineering-
Hale, Michael	statistics)
Hammond, Cheryl	Motoyama, Tetsuro
Hand, Michael	(joint psychology-statistics)
Hasza, David	Mowers, Ron
Ho, Chung-Man	(joint agronomy-statistics)
(joint industrial engineering-	Mowrey, Daniel
statistics)	Nagaraja, H. N.
Huang, Cheng-Chi	Parsian, Ahmad
(joint mathematics-statistics)	Peixoto, Julio
Huang, Elizabeth T.	

Ponder, Wendell	Simon, Barry
Rangachari, Lakshmi	Stewart, John
Richards, Winston	Tu, Ching-tsao
Sallas, William	
Sastrosowignjo, Soetarto	
Scott, Mark	**Non-degree Students**
Sedcole, Richard	
(joint agronomy-statistics)	Laidig, Friedrich
Shenk, Debra	Tobey, Malcom
Shu, Ven-Shion	

Bancroft Award

For the first time, a joint Ph.D. candidate was co-recipient of the Bancroft Award together with a student minoring in statistics. Tetsuro Motoyama and Paul Gibson were named the joint winners of the 1978 award.

Motoyama, a native of Japan, was selected for his outstanding performance among doctoral candidates with a joint major in statistics and another field. Motoyama received a B.A. in psychology from Oregon State University in 1973, a M.S. in psychology from I.S.U. in 1975, and a M.S. in statistics from I.S.U. in 1976. Motoyama has served as a research assistant to the Department of Statistics since 1975.

Gibson, a native of Texas, was selected for his outstanding performance as a doctoral candidate minoring in statistics. Gibson received his B.S. and M.S. degrees in agriculture and plant breeding, respectively from Texas A and M University. As a Ph.D. candidate in agronomy, he is currently conducting research at Hyderabad, India on the "Inheritance of Shoot Fly Resistance in Sorghum" using facilities provided by the Institute for Crops Research for the Semi-Arid tropics in Hyderabad, India.

The award honors T. A. Bancroft, Professor Emeritus of Statistics, and former director of the Statistical Laboratory and head of the Department of Statistics from 1950-1972. The award includes a cash prize together with a subscription to a statistically-oriented journal of the awardee's choice.

Mu Sigma Rho

The local chapter of Mu Sigma Rho held its annual banquet and spring initiation meeting on April 28. Professor John W. Tukey of Princeton University and Bell Telephone Laboratories was the guest speaker for the meeting which was held at the Scheman Building. The title of his talk was "Should You Fit, Smooth, or Soothe Your Data"? Nine graduate students, six undergraduates, and three faculty members were initiated as new members of Mu Sigma Rho, with an honorary membership being given to Professor Tukey.

The organization continued its service project which involved organizing and copying old exam questions in Statistics 104 and Statistics 327. The packets of examination questions are made available to students of these courses at a cost which is

less than that of photocopying. The aim of the project is to assist students in identifying the course concepts and to aid in preparation for examinations.

Officers for the 1978-79 academic year are:
President — Edward Henry Lee
Vice President — Linda K. Radach
Secretary-Treasurer — Promod Kumar Chandhok
Advisor — Dr. Donald K. Hotchkiss

Bill Sallas, outgoing chapter president, was the recipient of the 1977-78 Mu Sigma Rho award for academic excellence and service to Mu Sigma Rho.

Undergraduates

At the Scholarship Recognition Dinners May 8 and 9, two biometry students and one joint statistics-industrial administration major were honored. "High Scholarship Students by College and Class" honors the upper 2 percent of students by class in each of the colleges. David Serfling, biometry freshman, and Dale Zimmerman, biometry junior were so recognized in the College of Agriculture. Barbara Joy Kole, a statistics-industrial administration junior was recognized in the College of Sciences and Humanities. During fall quarter, Dale Zimmerman was selected as the recipient of a $300 Deere Scholarship.

Zimmerman is participating in the summer cooperative work-study program with the Iowa Crop and Livestock Reporting Service (USDA) in Des Moines. Linda Radach, a joint mathematics-statistics major will work as a statistician for the Corning Glass Company in Corning, New York this summer. Greg Kruger, also a joint mathematics-statistics junior, will work as a summer intern with the Weyerhaeuser Co. in Longview, Washington.

Richard Groeneveld, D. K. Hotchkiss, D. V. Huntsberger, and W. Q. Meeker served as undergraduate advisors for students majoring in statistics and for some undeclared students. Students who received the B.S. degree this year are:

    David R. Dunaway
    Robert J. Lamb
    David E. Rodas (Biometry)

David Dunaway entered military service as an officer in the U.S. Army. Robert J. Lamb continued as a graduate student in statistics. David Rodas is employed by the Crop and Livestock Reporting Service of the USDA in Wisconsin.

Statistics Club

The Statistics Club activities began in September with a picnic for members and statistics faculty at the home of Stat Club advisor Richard Groeneveld. Basketball and frisbee games preceded the picnic meal.

Later in the fall quarter, a meeting was held to discuss summer employment opportunities for undergraduates. Dale Jergensen described his work at a research station in Algona. Lynne Hoeksema discussed her work with the USDA Statistical Reporting Service and Dave Rodas described his experiences with the Iowa Livestock and Reporting Service, both located in Des Moines. Jill Lehman talked about her summer employment with Bell Labs in Holmdel, New Jersey.

In March, Stat Club members listened to Michael McMahon of Banker's Life Inc., of Des Moines describe the actuarial profession and its significance in the world today.

During spring quarter, Stat Club members went on a field trip to the Sundstrand Hydro-transmission Corporation in Ames. Former Iowa State Statistics major, Steve Johnson, described the way statistics is used by Sundstrand. Stat Club members were also given a tour of the Sundstrand Hydro-transmission facilities.

This year the club designed two displays for Veishea. For the first display, visitors were asked to measure their arm span. This information was then entered into a regression equation to estimate the visitor's height. Visitors could then check the estimates for accuracy. The second part of the exhibit consisted of challenging a computer to a game of blackjack. Spectators could view the card game results on a computer monitor.

William Meeker served as advisor in assisting Stat Club members with the Veishea display. A pizza party was held at Happy Joe's for all members who helped set up the Veishea display.

The recipient of the 1978 Statistics Club $200 scholarship was Dale Zimmerman.

Officers for 1978-79:
President — Dan Ivis
Vice-president — Mary Beth Pratt
Treasurer — Dale Zimmerman
Secretary — Stephanie Moss
Sciences and Humanities Council
Representative — Mary Beth Pratt

Seminars

Jeff Goebel, C. P. Cox, and S. Sukhatme comprised the committee which planned the weekly non-credit seminars. They were assisted by student representative, Wendell Ponder.

The seminars featured guest speakers, local faculty members, and students.

Topics and speakers for this year follow:

Statistical Laboratory Seminars

Summer, 1977

    July 20   On the Selection of Input Variables for Studying Large Computer Codes, W. J. Conover, Texas Tech University

    August 8   Application of Logistic Regression to Occupational Health Data, Gary Koch, University of North Carolina, Chapel Hill

Fall, 1977

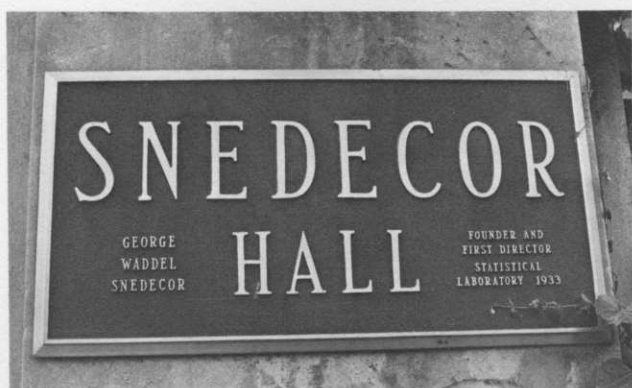   September 7   Statistics at ISU: Retrospect and Prospect, H. A. David

A Special Year in the Memory of George W. Snedecor

During 1977-78 George W. Snedecor's name was mentioned often. First, he was in the news as one of the top ten of 250 most cited scientists from the period 1961-75 according to the *Science Citation Index.* Second, the first Snedecor Award for the Best Paper in Biometry was presented in August, 1977, and third, the presentation of the 1978 Snedecor Award to Mark Scott marked the 25th year of the award which recognizes outstanding Ph.D. candidates in the ISU Department of Statistics. Accounts of the latter two items follow.
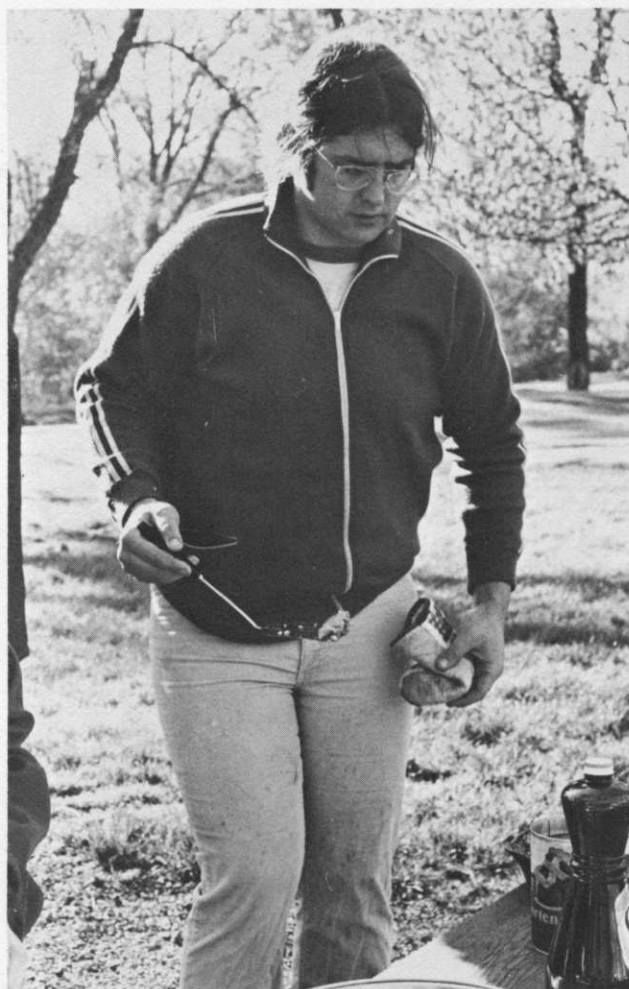
First George W. Snedecor International Award Presented

At the 1977 annual meeting of the American Statistical Association, A. P. Dawid of University College, London, was announced as the first recipient of the George W. Snedecor Award for the Best Paper in Biometry. This international award has been established through an agreement between the American Statistical Association and Iowa State University. It is funded through contributions from friends of George Snedecor. T. A. Bancroft played a prominent role in setting up the award.

Recipients of the award are selected by a committee representing the Western North American and Eastern North American Regions of the Biometric Society and the Biometrics Section of the ASA. The recipient must be formally nominated. Neither nominators nor nominated authors need to be members of any professional society. The nominee's work must (1) have been published in a refereed journal or in an edited book, monograph, or proceedings volume, (2) be written or translated into English, French, Spanish, or German, and (3) must be concerned with the methodology of biometry which may include such topics as biostatistics, biomathematics, or numerical taxonomy.

Not only this year's Snedecor awardee but also a good cook, Mark Scott prepared bacon and eggs for hungry Statistical Laboratory staff and students at the annual spring breakfast.

In 1969 the building housing the Statistical Laboratory was renamed Snedecor Hall honoring George W. Snedecor, founder and first director of the Statistical Laboratory.

Twenty-five Years of Snedecor Awardees

The presentation of the 1978 Snedecor Award to Mark Scott marked the silver anniversary of the award. The first award was presented in 1954, and in the official wording of the award criteria, it was set up to be given "... to the person judged, by a vote of the faculty in statistics, to be the most outstanding among those graduate students eligible for a particular year's award. Specifically, all students are eligible who (a) have either statistics majors or joint majors in statistics combined with some other subject-matter field and (b) have completed their Ph.D. preliminary examinations in statistics during the calendar year preceding the quarter in which the award is to be given."

Since 1954, twenty-seven Ph.D. candidates have received Snedecor Awards. Of these, one (Martin Robert Dorff, the 1959 recipient) is deceased, one is still in school, three work for the government, seven work for private industry, and fifteen are employed in various capacities by universities.

The following is a table which includes each awardee and his/her current position.

1954		
Helen Bozivich	Professor of Finance	Northern Illinois University, DeKalb, Illinois
1955		
Martin B. Wilk	Director of Corporate Planning	A T & T, New York City
1956		
John F. Pauls	Assistant Director of Statistical Services	Carter - Wallace, Inc., Cranbury, New Jersey
1957		
William H. Williams	Technical staff	Bell Laboratories, Murray Hill, New Jersey
1958		
Robert F. White	Director, Research Statistics	Hoffman - La Roche, Inc., Nutley, New Jersey
1960		
Scott Arnold Crane	Director of Research	Hallmark Cards, Inc., Kansas City, Missouri
1961		
J.N.K. Rao	Professor of Mathematics	Carleton University, Ottawa, Ontario
1962		
Edwin J. Hughes	Mathematician	Department of Defense, Washington, D.C.
1963		
Ronald R. Hocking	Distinguished Professor and Head of Department	Department of Statistics, Mississippi State, Mississippi
1964		
Fred Ramsey	Associate Professor of Statistics	Oregon State University, Corvallis, Oregon
1965		
Donna Jean Ruhl Brogan	Associate Professor of Statistics	Emory University, Atlanta, Georgia
1965		
David R. Thomas	Associate Professor	Oregon State University, Corvallis, Oregon
1966		
Frank B. Martin	Director of Statistical Center Associate Professor of Applied Statistics	University of Minnesota, St. Paul, Minnesota
1967		
Irving Hall	Staff Member of Statistics and Computing Division	Sandia Corporation, Albuquerque, New Mexico
1968		
Justus F. Seely	Associate Professor of Statistics	Oregon State University, Corvallis, Oregon
1969		
Peter O'Brien	Consultant	Mayo Clinic, Rochester, Minnesota
1970		
Ronald Gallant	Associate Professor of Statistics and Economics	N.C. State University, Raleigh, North Carolina
1971		
Richard Madsen	Associate Professor of Statistics	University of Missouri, Columbia, Missouri
1972		
Thomas J. Keefe	Assistant Professor of Statistics	Colorado State University, Fort Collins, Colorado
1973		
Kirk Wolter	Mathematical Statistician Associate Professor	U.S. Bureau of the Census, Suitland, Maryland The George Washington University, Washington, D.C.
1973		
Kazimierz F. Karpinski	Statistical Consultant	Department of National Health and Welfare, Vanier, Ontario
1974		
Bruce Bowerman	Associate Professor in Business Analysis	Miami University of Ohio, Oxford, Ohio
1975		
David Dickey	Assistant Professor of Statistics	N.C. State University, Raleigh, North Carolina
1976		
Shie-Shien Yang	Assistant Professor of Mathematics	Indiana University, Bloomington, Indiana
1977		
Shriram Biyani	Visiting appointment	University of Minnesota, St. Paul
1978		
Mark Scott	Graduate Teaching Assistant in Statistics	Iowa State University

J. N. K. Rao and Martin B. Wilk are members of the International Statistical Institute.

Ronald R. Hocking, J. N. K. Rao, William H. Williams and Martin B. Wilk are fellows of the American Statistical Association.

J. N. K. Rao and Martin B. Wilk are fellows of the Institute of Mathematical Statistics and fellows of the American Association for the Advancement of Science.

Of the Snedecor awardees, many have been prolific in writing research papers; three have authored or co-authored books; three have had various editorial assignments; three have served on national statistical committees; three have served on various national committees; one received the Wilcoxon Award for a Technometrics paper in 1971 and a Youden Award for a Technometrics paper in 1976; and another received an award for outstanding graduate instruction.