STATISTICAL LABORATORY

established 1933

$$\sigma^2 \quad \mu \quad \Omega \quad \Sigma \quad \chi^2 \quad \beta$$

annual report

Contents

THE STATISTICAL LABORATORY
Iowa State University
1974-75 Annual Report

Personnel

H. A. David directs the Iowa State University Statistical Center which includes: The Statistical Laboratory, an institute under the president's office; the Department of Statistics in the College of Sciences and Humanities; the Statistics Department of the Agriculture and Home Economics Experiment Station; and the statistics participants in the Engineering Research Institute. Staff members are shared among these components, and salaries are often budgeted from more than one source, including research grants.

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Promotions effective July 1, 1974, in the Department were: Barry Arnold from associate professor to professor; Richard Mensing and Vincent Sposito from assistant professor to associate professor; Ted Emigh from graduate assistant to research associate. Beginning October 1, Chaturvedula Asok was promoted from research associate to post-doctoral associate. Dale Umbach and Barry Simon began their new duties as instructors September 1, having previously served as graduate assistants.

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Staff members new to the Department this year include Tom Bubolz and Wendell Ponder, instructors. Their appointments commenced August 1 and September 1, respectively. James Gentle, who received his Ph.D. in statistics from Texas A & M, became an assistant professor September 1. His area of emphasis is statistical computing. After a year's absence, Carol (Holly) Fuchs returned to the Department as a temporary associate professor. She taught undergraduate courses and plans to pursue her own research next year. Visiting assistant professors for the academic year were Mohamed El-Sabbagh and Prem Talwar. Dr. Talwar has accepted a position as assistant professor in the Department of Mathematics and Statistics, University of Guelph, Ontario, Canada.

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Invitations were accepted by several faculty members to join staffs of other institutions on a temporary or visiting basis. B. V. Sukhatme was a visiting faculty member in the Department of Statistics, University of Waterloo, Waterloo, Canada, June, 1974. Oscar Kempthorne was a visiting professor in the Department of Biostatistics, School of Public Health, University of Washington. He taught a course in design of experiments and conducted six seminars on the foundations of statistics. Donovan J. Thompson, Ph.D., ISU, 1951, chairman of the department, issued the invitation to Dr. Kempthorne.

Leroy Wolins was invited to the University of Marburg, Germany, to teach multivariate analysis to students and faculty in the Psychology Department. While spending the month of June, 1975, there on a visiting faculty appointment, he gave additional lectures on other statistical methods.

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Chien-Pai Han will be participating in the Iowa State University Faculty Improvement leave program. He has accepted a research appointment with the Statistics Department at Stanford University, Stanford, California, for the 1975-76 academic year and will be working in the area of multivariate analysis. Barry Arnold and Richard Groeneveld have been on leaves of absence from the Department. Dr. Arnold held an appointment with the AID Peru Agrarian Reform Project in Lima, Peru. Dr. Groeneveld has been a visiting associate professor, Department of Mathematics, Dartmouth College, Hanover, New Hampshire. They plan to return to Ames during the summer, 1975.

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Resignations occurring during the fiscal year were Bruce Bowerman, Martin O'Connell, and Wendell Smith.

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Malay Ghosh continues as a visiting associate professor while on leave from the Indian Statistical Institute. His areas of expertise are probability and statistical inference. His Ph.D. was in Statistics from the University of North Carolina. Summer visiting staff members include Bruce Bowerman, James Cornette, Benny Levikson, and Robin Thompson. The latter three will be cooperating with Drs. Kempthorne and Pollak in mathematical and statistical genetic research for NIH and AES project 1669. Dr. Cornette is visiting from the Department of Mathematics, Iowa State University; Dr. Levikson is currently teaching at Purdue University in the Department of Mathematical Sciences; and Robin Thompson is a researcher in the Unit of Statistics, University of Edinburgh, Edinburgh, Scotland. Dr. Bowerman, Ph.D. in Statistics, ISU, 1974, will assist H. T. David with the teaching of Statistics 644 second summer session.

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Beginning July 1, 1975, David Harville will fill the senior vacancy created by the death of George Zyskind. Dr. Harville is an Iowa State alumnus, having received his B.S. degree here in Dairy Science in 1962. His graduate work for the M.S. and Ph.D. degrees was completed at Cornell University where his areas of emphasis were animal breeding, statistics, and genetics. For the past ten years he has been employed as a research mathematical statistician, Aerospace Research Laboratories, Wright-Patterson Air Force Base,

Ohio. He has been a part-time instructor at Ohio State Graduate Center and an adjunct associate professor, Mathematics Department, Wright State University, 1966-1975. Dr. Harville will be engaged primarily in research and will teach courses in design of experiments and linear model theory.

On September 1, William Meeker will join the faculty as an assistant professor to teach undergraduate students from industrial administration and to do related research. Dr. Meeker's dissertation research was in administrative and engineering statistics. He received his B.S. degree from Clarkson College, Potsdam, N. Y., in 1972; his M.S. and Ph.D. degrees from Union College, Schenectady, New York. He served as a research fellow and part-time instructor at Union College and was employed during the summers of 1973 and 1974 as a statistician with General Electric.

John Ingram has accepted a one-year postdoctoral associate appointment to assist Roy Hickman in the Survey Section, beginning July 1. Dr. Ingram will be on leave from his position as associate professor, Florida Technological University, Orlando, Florida.

Members of the Statistical Center, including graduate students, follow:

Statistical Laboratory Staff— Fiscal Year 1974-75

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

T. A. Bancroft

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

Donald K. Hotchkiss

David V. Huntsberger

Oscar Kempthorne—Distinguished Professor, College of Sciences and Humanities

Edward Pollak—joint appointment with Department of Genetics

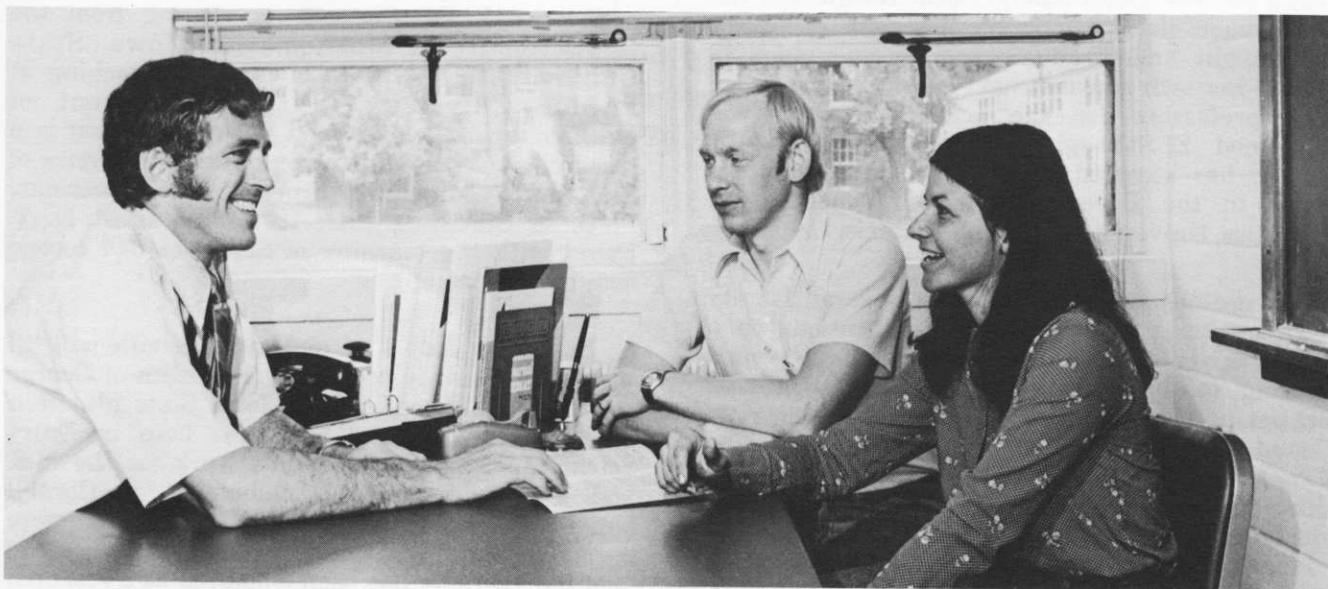Gordon Rausser—faculty status in Statistics as well as Economics

Norman Strand—Professor Emeritus, visiting September, 1974; January, 1975

B. V. Sukhatme

Richard D. Warren—joint appointment with Department of Sociology and Anthropology

Leroy Wolins—joint appointment with Department of Psychology

George Zyskind—deceased, September 13, 1974

Dr. Dean Isaacson (left), graduate student advisor, checks summer schedule with Donald Barron and Gabriela Strangenhaus, graduate students.

James L. Cornette—visiting, summers 1974 and 1975

K. Ruben Gabriel—visiting, summer, 1974

Janos Galambos—visiting, summer, 1974

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

Associate Professors

Carol E. (Holly) Fuchs (temporary)

Malay Ghosh—visiting

Richard A. Groeneveld—on Faculty Improvement Leave—September, 1974-June, 1975

Chien-Pai Han

Roy D. Hickman

Paul N. Hinz—faculty status in Forestry as well as Statistics

Dean L. Isaacson—joint appointment with Department of Mathematics

William J. Kennedy

Glen D. Meeden

Richard W. Mensing

Vincent A. Sposito—joint appointment with Computation Center

Robert F. Strahan—joint appointment with Department of Psychology

Assistant Professors

Theodore B. Bailey

Harold D. Baker

Mohamed El-Sabbagh—visiting

James E. Gentle

Jeffery J. Goebel

Lawrence Promnitz—faculty status in Statistics as well as Forestry

Shushikala B. Sukhatme

Prem Talwar—visitng

Gordon Booth—USDA Collaborator

Gauri L. Ghai—visiting, summer, 1974

Benny Levikson—visiting, summer, 1975

Melvin L. Moeschberger—visiting, summer, 1974

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

Instructors and Associates

John Aleong

Tom Bubolz—beginning August 1

Randy Carter—through August 31

Michael Coveyou—joint appointment with Department of Political Science

David Dickey—through August 31

Richard Dorsch

Paul DuBose

Ted Emigh—beginning July 1

James Hansen—beginning December 1

Wendell Ponder—beginning September 1

Barry Simon—beginning September 1

Dale Umbach—beginning September 1

Robin Thompson—visiting research associate, summer, 1975

Postdoctoral Associate

Chaturvedula Asok, beginning October 1

Collaborator

Charles Graham—USDA Collaborator

Graduate Assistants

The status of a graduate student often changes. Students who have held the title of graduate assistant sometime during the year are listed here:

Akin, Donald	Knight, Ricky
Anderson, Jerry	Lam, Wai-Chung
Andriano, Kim	Matsui, Tsuru
Asok, Chaturvedula	McCormick, Gary
Biyani, Shriram	Midha, Chand
Carter, Randy	Mo, Wing-hung
Chen, Jengrong	Moritz, Tom
Chung, Richard	Mundstock, Elsa
Clarkson, Brenda	Otte, Hans
Diaz, Francis (undergraduate)	Pinski, Kenneth
	Richards, Winston
Dickey, David	Schmittling, Gordon
Doctor, Pamela	Scholl, Mary
England, Marijane	Sedcole, Richard
Gust, Cathryn	Shenk, Debra
Hajela, Devendra	Shu, Ven Shion
Hallaman, Karen	Simon, Barry
Hanley, Janet	Sung, Bok Park
Hansen, James	Tai, Kuen-Jing Joyce
Hasza, David	Thomas, Lana
Hidiroglou, Michael	Tomasiewicz, Diane
Iwuora, Grace	Tu, Ching-Tsao
Johnson, Steven (undergraduate)	Wang, George
	Werner, Neil
Kamins, Michael	Wolter, Kirk
Kim, Geung Ho	Yang, Shie-Shien
Kinyon, Lawrence	Yen, Jenn-Yung
Klemm, Rebecca	zumBrunnen, James

Supported Graduate Students

Alders, Dean—Department of Mathematics, ISU

Al-Rawi, Zeyad—Government of Iraq

Aziz, Mohammad—Ag. Development Council Fellowship, (joint sociology—statistics)
Barrales, Luis—AID and Chilean Government
Barron, Donald—Department of Mathematics, ISU
Burguette-Hernandez, Francisco—Nat. Council of Sci. and Tech. and Ford Foundation
Carvalho, Jose—University of Campinas, Brazil
Chand, Lal—AID
Ervan, Mohamed—FAO
Gama, Jino—Government of Uganda
Gomez, Santiago—USAID
Herrera-Haro, Jose—Nat. Council of Sci. and Tech. and Ford Foundation
Huang, Cheng-Chi—Department of Mathematics, ISU (joint mathematics—statistics)
Islam, Sheikh—FAO
Iwuora, Grace—University of Nigeria
Khuantham, Ananchai—Kasetsart University (joint forestry-statistics)
Kiregyera, Ben—Government of Uganda
Lamyordmakpol, Anuchit—Government of Thailand
Leelasuwanich, Thawach—AID (joint economics-statistics)
Mundstock, Elsa Contreras—Central Bank of Venezuela
Pareja, Gilda—USAID
Parvin-Jahromi, K.—Iran Ministry of Science and Higher Education
Pashazadeh-Monajemi, M. B.—Iran Min. of Sci. and Higher Education
Phoeyglin, Surin—National Research Council
Robles, Julio Cesar—AID, Peru
Sakarindr, Preecha—Rockefeller Foundation—Thailand (joint economics-statistics)
Sirisukdi, Vannapha—AID
Sotres, David—Nat. Council of Sci. and Tech. and Ford Foundation
Stangenhaus, Gabriela—Univ. of Campinas, Brazil
Villasenor, Jose—Ford Foundation, Mexico
Viroonsri, Boonchai—AID

Self-supporting Graduate Students

Bernhardt, Vickie
Bonczkowski, Harry
Bondy, Eric
Chen, Mon-Gy
Cheng, Kou-Ping
Clark, Cynthia
Crouse, Ken (joint computer science-statistics)
Doctor, Pamela
Fernandez, Irma
Hawley, Sandra (non-degree)
Ho, Chung Man
Meeker, Jeffery
Mellon, James
Perez, Margarita
Solomon, Ann
Sotres, Olga

Statistical Data Processing Service

Bud J. Meador, Supervisor
Charlotte Bentley, Data Processor - through February

Survey Section

Carroll Arthur, Statistical Data Processor
Hazel Cook, Survey Supervisor
Gwen Entsminger, Key Entry Operator
Dixie Graham, Secretary—November through April
Evelyn Green—Survey Supervisor
Marion Martin, Statistical Data Processor
Marjorie Mason, Survey Supervisor
Sylvia McNulty, Secretary-Bookkeeper
Margaret Nichols, Secretary
Dallis Sonksen, Secretary—beginning May 1
Harvey Terpstra, Jr., System Analyst
Anna Woodrow, Survey Supervisor

Statistical Clerks

Karen Bruce—beginning January 1
Mary Farr—beginning February 1
Ava Klopf
Sylvia Larson
Donna Omundson—beginning October 1
Florence Osam
Nancy Wells—beginning March 1

General Office Staff

Margaret G. Kirwin, Administrative Assistant
Avonelle Jacobson, Program Coordinator
Kathleen Ringgenberg, Accountant—through July
Betty Ibrahim, Accountant—beginning January 1
Kathleen Shaver, Information Assistant
Phyllis Carr, Secretary—Experimental Design—Genetic Statistics Section
Carol Dunn, Secretary—Statistical Numerical Analysis and Data Processing Section—through May
Jan Ellsworth, Secretary
Norma Elwick, Secretary
Karen Meimann Gogerty, Secretary
Peggy Nelson, Secretary
Nancy Piersol, Secretary—Statistical Numerical Analysis and Data Processing Section—beginning June 1
Beverly Upchurch, Secretary

Susan Alice Brown

1934 - 74

Susan Alice Brown, Statistical Laboratory editor-technical writer from 1964 to 1974, died September 11, 1974, in Ames, Iowa. She held bachelors and masters degrees in journalism and mass communication from Iowa State University.

At the Statistical Laboratory, she was responsible for the publication of the annual report, for editing manuscripsts for staff members, and for compiling data for a variety of university and off-campus reports. A member of the American Statistical Association, she was editorial assistant to Dr. T. A. Bancroft during preparation of the book, *Statistical Papers in Honor of George W. Snedecor*, ISU Press, 1972.

Sue was an active member of several professional organizations and participated in a leadership capacity at local, state, and national levels, presenting papers, symposiums, and seminars. Offices which she held were the following: state treasurer, Iowa Home Economics Association; Publications Advertising Advisory Committee, American Home Economics Association; national treasurer, national vice president for student chapters, and national vice president for members at large of Theta Sigma Phi, a professional society for women in journalism and communications. Mortar Board and Phi Upsilon Omicron (home economics) honored her with membership.

In 1959, Miss Brown sponsored the organization of the Ames chapter of Women in Communication, Inc. (WICI). She held all offices of the group, was advisor to the student chapter, and held several offices in the national WICI.

Sue will be remembered by Statistical Laboratory staff and former students as the person responsible for all the details of editing this annual report—from the initial challenge to staff members to submit their assignments on schedule to the final mailing of the published copies. The high quality of her professional work was recognized through letters of commendation received by the Statistical Laboratory, through a citation presented to her by the Statistical Laboratory staff, and through a certificate of honor awarded to her by the Ames professional chapter of Women In Communication, Inc. On a national level, she was named to Who's Who of American Women and Foremost Women in Communications.

George W. Snedecor Memorial Fund

A memorial fund to honor George W. Snedecor in some continuing manner, preferably at the national or international level, was established by the Honors and Awards Committee of the Iowa State University Statistical Laboratory.

To date, total gifts have slightly surpassed $2,000. Donations have been received from 68 contributors in the United States and a total of 14 contributors from Canada, Mexico, Austria, Germany, India, Ghana, Australia, and Japan. Among the donors were statisticians from government, universities, and business-industry. The diversity of their interests ranged from the highly theoretical statistics to the most applied.

A note of appreciation is extended to each person who has donated to this fund, and further contributions would be welcome. Checks may be made payable to Snedecor Fund, Statistical Laboratory, and mailed to 102 Snedecor Hall, Iowa State University, Ames, Iowa 50010.

The June, 1975, issue of *Biometrics* is dedicated to Dr. Snedecor. Gertrude Cox and Paul Homeyer are coauthors of the featured article, "Professional and Personal Glimpses of George W. Snedecor," pp. 265-301.

George Zyskind Memorial Lecture Fund

Many friends of George Zyskind, from all over the world, have expressed their shock at his untimely death and have responded generously to the announcement of the fund set up in his memory. An obituary article by Oscar Kempthorne was published in the May issue of *The American Statistician*.

Professor Geoffrey Watson of Princeton University has agreed to give the first lecture in what is hoped to be an annual series reflecting George's varied interests. The lecture is scheduled for delivery October 1, 1975, at the Statistical Laboratory.

Consulting
and Cooperative Research

One of the functions of the Statistical Laboratory is to assist Iowa State University researchers (students or faculty members) and off-campus individuals or agencies with statistical problems involving any phase of a research project. Consultation is frequently given on questions relating to the design of an experiment, selection of a sample, preparation of instruments for data collection, analysis of data, and interpretation of findings.

All faculty members and some graduate research assistants are available for consulting. However, some are budgeted primarily in this area so that statistical consulting can be available to staff and students without cost (computer charges excluded). If campus research projects result in a published paper, the consulting statistician may be acknowledged as a coauthor. Examples may be seen in the publications section of this report. Research projects of graduate students are often written into theses or dissertations and appreciation to the statistician may be expressed in the acknowledgements.

Statistical Laboratory consultants are also continually engaged in research to improve existing techniques and to develop new software.

The paragraphs which follow are presented to show the diversity of the consulting and are representative of the range of research projects in which the Statistical Laboratory becomes involved. This is not intended to be a complete list of the current fiscal year's consulting activities.

Agriculture
Home Economics
Social Sciences

Richard Warren, joint appointment with Sociology and Anthropology, served as a consultant for approximately fifty research studies, primarily for graduate students in sociology, education, and family environment.

Some of the topic areas on which Dr. Warren was consulted regarding design and analysis of the studies include: effect of physical attractiveness of client on perceptions of counselor; relationship between group structure and the fertility attitudes and behavior of individual group members; comparison of two teacher education programs; influence of evaluative feedback on teacher performance; the substitutability and interchange-ability of outdoor recreation activities; assessing change in affective behavior of students participating in food production management course, inter-relationships of husband and wife perceptions; individuals active in community decision making processes; and influence of social rank on consensus and role performance in normative organizations.

Dr. Warren was the consultant for a study on the measurement of interorganizational relations (IOR). Eight items indicating IOR from low to high intensity were postulated: (1) director awareness; (2) director acquaintance; (3) director interaction; (4) information exchange; (5) resource exchange; (6) overlapping board membership; (7) joint programs; and (8) written agreements. The theoretical order of these items was examined empirically across four types of organizations distinguished by funding source: (1) voluntary; (2) public; (3) professional; and (4) interorganizational. In another sociological study on the influence of response rate, the measurement characteristics and relationships among variables were analyzed using data from four waves of returned mailed questionnaires. In a third study, regression analysis was used in comparing two models of compliance and effectiveness in complex organizations.

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Robert Strahan, joint appointment with Psychology, regularly consults with a large number of graduate students and faculty, primarily but not entirely from Psychology. Dr. Strahan is the principal investigator for an Iowa State University Grant, Semantic Style in Psychological Assessment.

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Leroy Wolins, also sharing an appointment with Psychology, assisted 75 clients with statistical consulting. Generally, his consulting this year was dominated with analysis of covariance problems with several between-group factors and several within-group factors and unequal numbers in the between-group factors. Researchers needed professional advice to take the covariate out of the within-group analysis.

A study of interest to Dr. Wolins was prepared by a graduate student in child development to assess "shyness" in children. Questionnaire responses

to behavioral descriptions of shy behaviors were obtained from parents, teachers, and peers of elementary school children. For many of the questions, there was agreement among peers, teachers, and mothers about which children were shy, but the fathers agreed only with the mothers on certain questions. Shyness is sometimes symptomatic of maladjustment, and the questionnaire developed in this study may be useful for identifying children who might benefit from counseling.

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Michael Coveyou, joint appointment with Political Science, was consulted on a study of career patterns of members of the Pennsylvania Colonial Assembly and Justices of the Peace which is a continuation of a study begun by a history faculty member last year. Factors studied were identification of leadership, exclusive committee functions, and relationship to social variables. Univariate and bivariate descriptive measures and SPSS computer routine were employed. Another continuing research project in Political Science involves career specialization of regional bureaucrats in the Soviet Union. Mr. Coveyou assisted the investigator with descriptive measures of bivariate association. Constructing a questionnaire posed a problem for a faculty member assessing the relationship in secondary schools between athletics and educational policies. Areas of concern were sexual discrimination in hiring, impact of teacher/coach upon students' political views in social studies classroom and career patterns of educational administrators. Mr. Coveyou's research centers around the topic "Citizens' Views of Political Parties: Methodology and Conceptual Problems."

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Carol Fuchs and Leroy Wolins assisted a faculty member from Home Economics Education with construction of items and designing a score sheet for judging effectiveness of teaching ability. ANOV and correlation techniques were used in the analysis of the research. ANOV techniques were also used in a study to ascertain if treatment, training, color, shape, and/or density influence the ability of a subject to recognize a stimulus. A third consultation used group comparison in analyzing data collected to decide if instruction affects handball ability.

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B. V. Sukhatme assisted on two investigations: a student in Industrial Administration had collected data which was processed with regression analysis techniques; a student in Earth Sciences needed advice on constructing a questionnaire.

Various commercial linear programming packages were compared for efficiency by the Computer Science Department with the assistance of Vincent Sposito, consultant. Dr. Sposito also assisted a client from Economics by using the quadratic programming package (Zorilla) to develop optimal portfolios based on quarterly data from 1960-1972. James Gentle used analysis of covariance and correlation analysis for an investigator who wanted to assess the effects of participation in human potential laboratory seminars on scores on the personal orientation inventory tests. Dr. Gentle consulted with a client who had collected data in an attempt to identify varieties of soybeans resistant to root decay within various environments. Statistical processes used in the analysis were regression and correlation.

Engineering Research Institute

H. T. David and Richard W. Mensing are the two consultants partially supported by the Engineering Research Institute. Seven departments within the College of Engineering sought their assistance in experimental design and/or data analysis this year. In conjunction with the current emphasis on redeveloping Iowa's coal industry, several researchers in the Chemical Engineering Department were assisted with experiments related to the gasification of coal. Another client in that department was fitting a second order response surface to the output of a chemical process.

A researcher from Civil Engineering was investigating the uniformity of pollutants in space and time; another was analyzing the deterioration over time of the filter efficiency in a water purification process. The consultants assisted in developing methods of comparing the goodness of fit of two models for estimating gravity anomalies throughout the earth's gravity field and discussed the comparison of several methods useful for representing topographic surfaces.

Electrical Engineering requested advice on the linear program formulation of a regional energy requirement model.

Industrial Engineering researchers were involved in a research project with the local city hospital. Drs. Mensing and David were consulted in the development of regression models for predicting demand and in-patient days for hospital facilities. Development of methods for modeling the energy potential of wind in rural Iowa areas was another Industrial Engineering project which needed statistical consultants' advice.

In the Department of Agriculture Engineering, a researcher was studying moisture transfer in bulk storage of grains and requested data analysis. Other problems discussed were: error propagation in failure studies (Mechanical Engineering); variance of measurements subject to roundoff (Metallurgy).

Agriculture and Home Economics Experiment Station

Statistical consulting services for a large number of staff members and students on campus are financed through the Iowa Agriculture and Home Economics Experiment Station.

Project #101, Statistical Services in the Animal Sciences and Plant Sciences, supported the consulting work of D. F. Cox, Paul Hinz, Donald Hotchkiss, Ted Bailey, and five graduate assistants, John Aleong, Jerry Anderson, Richard Chung, Brenda Clarkson, and George Yen.

The consulting work with members of the Agriculture Experiment Station involves a continuing stream of challenging situations in the analysis of data. Very few cases can be described as routine. The depth and detail to which particular analyses are carried depend on the interests of the research worker involved and the time available. A few of the situations encountered during the last year are described below.

The influence of cyclamates on glucose tolerance was studied in a small experiment with rats. Rats showing evidence of diabetes were used. One group was fed a normal control diet and another group was fed a diet containing cyclamates. The glucose test was administered before and after the diet was fed. The difference between the two tests was larger in the animals receiving cyclamates. The size of the experiment, five experimental and seven control animals, did not provide enough information for the differences to reach conventional levels of statistical significance, but trends were evident. Several different techniques were used in the analysis but only a larger experiment seemed to be the answer to establishing the trends with moderate reliability.

The effects of environmental noise on the growth and physiology of hooded rats was studied. The experimental group was subjected to random bursts of "white noise" while the controls remained in a quiet environment. Almost no differences between the groups were found in measures of growth, blood counts, and antibody titers.

Many studies in physiology require a measure of DNA to assess cell growth in a tissue. The assay for DNA relies on optical density, and unknowns are compared to known standards obtained from N I H and other central laboratories. The validity of the assay requires a linearity in the response measured in optical density. Small but real deviations from linearity were noted in a whole series of assays done on tissues where the DNA concentration was very low. The nature of the discrepencies and other aspects of the response led to a review of the techniques and eventually an improvement which gave a valid linear response to known amounts of DNA.

A new type of meat tenderizer was evaluated using an inexperienced taste panel of citizens from an eastern Iowa community. Two types of meat were used. The first was from ordinary fat cattle and was handled as it normally would be in the trade. The second was from range cattle that had not been fed corn, and the meat from these animals was subjected to a mechanical tenderizing process. Approximately 30 tasters were used, each person tasting six pieces of meat from each treatment. The panel members were surprisingly consistent in ranking the meat on such criteria as tenderness, juiciness, and flavor. The study showed that even with mechanical tenderizing the meat from range cattle was not comparable to that from fat cattle.

A very large factorial experiment was carried out in food technology to evaluate different preservatives used in meat processing. Two levels of each of seven factors were combined into all factorial combinations and replicated three times. The main objective was to see if any of the preservatives interfered with the action of others. It was felt that many processors faced with a growing array of different agents, to retard bacterial growth, might just put a little of each into their product. The possibility of synergistic effects and inactivation of one compound by another was explored. The best preservation occurred with a combination of nitrite and glucose when measured in terms of inhibition of a particular organism. Many other aspects need to be explored including high order interactions and correlations. The data handling required to analyze an experiment with seven factors each at two levels arranged in three replications was substantial but manageable within our routine capability with the standard computing systems that we use.

Some experimental work with fleas from the Department of Entomology was carried out to see if advantage could be taken of the observation that in a given set of developing larvae, the females emerge before the males. It would be a useful laboratory technique to be able to easily and mechanically harvest virgin females without examining each individual. Some experiments were run to determine the time for the first male to appear and to examine factors, such as temperature, that might influence it. The work was preliminary but provided enough information to warrant continuing research.

Some work in entomology has suggested that the point where various stages of an insect reach a supercooled condition could be useful in predicting wintering properties. The supercooled point depends on the rate of cooling and, therefore, the size of instar that is examined. Black cut worms from two different states were used and a large factorial

experiment was designed to investigate the supercooled point for various stages and sources of the insect.

The mechanical properties of exotic maize plant introductions were studied in an experiment from Botany. Corn plants attacked by fungus can buckle and such lodging often reduces yield. The structural components of the stalk are, therefore, important and need evaluation in new sources of germ plasm. The study measured such things as wall thickness, maximum fiber stress, breaking elongation, and calculated critical buckling stress. Major differences among lines of corn were noted.

The dimensions of the thyroid gland in dogs were studied in Veterinary Anatomy. The length, width, and thickness of the right and left lobes were measured in 21 male and 25 female dogs. It was found that the lengths of the left lobes were significantly greater than the right lobes in both sexes, but other dimensional differences were not detectable.

Work continues in Home Economics on the effects of substituting soy protein for raw meat on the nutritional content and sensory evaluations of meat loaf. The substitution of soy protein has important implications in institutional cooking and school lunch programs. The work also included an evaluation of microwave and conventional ovens. An expert taste panel provided the sensory evaluations of the various products cooked by the two methods. Differences in initial fat content of the meat and the prepared products caused some difficulty in the interpretation.

A machine used to crush corn was examined in a study in Agronomy. The force required to crush the corn was measured for different sizes of samples of grain. The response on the original scale used was clearly curvilinear and the mean and variance were related. A transformation to the square root of the original scale corrected the dependence between the mean and the variance and linearized the response.

A study in Veterinary Clinical Sciences was designed to measure the rate of disappearance of maternal antibodies from the blood of the newborn. These antibodies are provided by the mother to the newborn and give transient protection during the first weeks of life. The rate they disappear depends on the nature of the antibody. A useful statistic is the half-life or the time required for one half the initial concentration to disappear. The response with time is such that the logarithm of the antibody titer is linear and makes the estimation of half-life a direct application of a linear model.

Agronomy conducted a study of the introgression of exotic oat germplasm into an adapted oat variety. Specific objective of the work involved the estimation of magnitudes and changes of genetic variances and covariances in populations derived from backcross generations. Botany

Department researchers sought assistance in designing and analyzing experiments investigating the effect of sodium bisulfite (a possible environmental pollutant produced by the burning of coal).

Data from a study of the effects of chemical treatments on nematode populations in corn were gathered from 10 locations in Iowa. Attempts are also being made to see if a relationship can be established between yield and the number of nematodes of several different species. Another study was designed to investigate the influence of various herbicide treatments and tillage practices on the depth of germination of foxtail and velvet leaf in corn and soybean fields. Statistical assistance was given on a project to evaluate several methods of sampling green cloverworm populations in soybean fields.

Statistical Numerical Analysis and Data Processing Section

This section of the Statistical Laboratory has the primary mission of assisting research workers with scientific computer applications. Faculty members of the section also conduct research and teach courses in scientific applications of digital computers.

Section personnel were actively involved in work on many different projects during the year. The majority of these projects were in support of research conducted on campus. A brief description of a few of these projects is contained in succeeding paragraphs.

All components of the Career Education Needs Information System (CENIS) were tested and used by the Iowa State Department of Public Instruction during the 1974-75 fiscal year. The system performed exceptionally well on its first full-scale test. It is expected that the system will, in future years, provide extremely valuable information to long-range curriculum planning staffs in the 15 community colleges in Iowa. Programmers who worked on the CENIS project during the year included Gary McCormick, Jim zumBrunnen, and Gordon Schmittling.

Several different projects involving data retrieval and report generation, using the 1970 U. S. Population and Housing census data, were completed. Bud Meador, Lana Thomas, and James Chen were most heavily engaged in these activities. Several hundred data tapes containing data from counts one through five are stored in the section's tape library.

Data on fatal farm accidents during the years 1933-1972 were analyzed by Tom Bubolz and Ken Pinski. A final report on the findings in this analysis will be published as an Agriculture Ex-

tension Service Bulletin. A continuation of this project, which will be completed in 1976, involved consolidation and analysis of the 1975 Iowa Farm Accident Survey conducted as part of a national survey.

Rick Knight, Joyce Tai, Geung Ho Kim, Dr. Bubolz, and Dr. Kennedy worked with researchers from the State Conservation Commission on analysis and report generation for eight different wild game, waterfowl, and fish studies. The largest of these projects involved analysis of the state's deer season outcomes.

Work continued during the year on various aspects of a large food and nutrition research project. Janet Hanley and Dr. Bubolz assisted researchers from the College of Home Economics with several different computer analyses of human diet as a part of this project. Special computer programs were also written to provide specific analyses which indicate different types of dietary deficiencies in given menu plans.

A large test and evaluation project on mathematical programming software packages was conducted by Dr. Sposito and Becky Klemm. The purpose of this project was to determine whether current software support in this area could be improved. Results of the analysis did not indicate that a change in software support was needed.

Extended precision FORTRAN routines from the IMSL library were reprogrammed for the IBM 370 system to take advantage of additional hardware in this computer. An impressively large decrease in execution time was achieved over the time required for comparable execution in the IBM 360 computer using the standard IMSL library routines. Dr. Gentle was the project leader on this project which was done in cooperation with Dr. James Hoekstra of the ISU Computation Center.

Kim Andriano worked with researchers from the College of Veterinary Medicine on a regional data collection and reporting system for animal diagnosis data. The system, which was started by Dr. Hutton of the College of Veterinary Medicine, will be modified and maintained on a continuing basis by the section.

Maintenance and consulting operations on the SPSS, SAS, SOUPAC, and section "zoo" programs continued throughout the year. Version six of SPSS was installed near the end of the year. The responsibility for maintenance and distribution of the "Reliability" subprogram SPSS was assumed by the section.

Survey Section

The Survey Section, directed by Roy D. Hickman, has the responsibility of providing consultation and direct operational assistance to research workers in sample design and in the planning and conducting of surveys. Staff members assist with questionnaire design and construction; sample design and selection; organization and supervision of field data collection by personal interview, telephone or mail; editing and coding of data for processing; and data summarization and analysis. Professional staff members also conduct research and teach courses in the areas of sampling, survey design, and statistical methods.

In the study of driver education students and programs in Iowa high schools, an additional 500 students were interviewed to obtain information about an experimental driver education curriculum used in several schools. Analysis of the data was completed, and the Iowa Department of Public Instruction is preparing the final report of the project. A sample of incorporated areas in Iowa was designed and drawn for a study of land use trends in the state. Assistance was given in developing questionnaires which were sent to governing officials of the incorporated areas, Iowa county extension directors, and various state agencies. Data was also collected and tabulated from secondary sources. Estimates of the present major uses of Iowa's land and of future land use were computed. Richard Dorsch assumed primary responsibility in direction of these two projects.

A statewide sample of business and manufacturing firms and certain governmental bodies (such as municipalities and school districts) was selected for researchers from the Iowa Department of Public Instruction. The primary purpose of this project is to estimate the in-state demand for workers in various categories for which training programs have been or may be established in the area community colleges. The Survey Group participated in a previous study carried out in 1972. After data collection, the data will be transferred to computer storage, editing routines performed, and estimation procedures carried out.

A sample of households was selected for researchers from the Division of Preventive Medicine at the Mayo Clinic in Rochester, Minnesota, who were interested in assessing the impact on a particular community of the establishment of a family practitioner in an area heretofore considered to be deficient in medical services. Interviewing was to be carried out before the doctor began his practice with follow-up studies to be made at a later date. Personnel of the Survey Section assisted in training the interviewers, but data collection and analysis were carried out by the researchers. Harold Baker assumed major responsibility for direction of this project.

A stratified area sample of rural farm households in Iowa was selected for the Iowa portion of a north central regional project concerned with rural children's mental and social development. Within the sample households, children at

three age levels will be identified for a longitudinal study extending over a five-year period. The research is being conducted by members of the Department of Child Development.

The universe of interest for a study carried out by researchers in the Department of Economics consisted of all estates in Iowa that were closed during 1972. A subsample of estates was selected from records at courthouses of counties selected at the first stage. Stratification for primary selection was based upon judicial districts within the state.

A sample of households was selected from telephone directories for a study of transportation patterns in "rural" Iowa. The researchers, a civil engineer and a sociologist, were interested not only in comparing transportation patterns in nine regions but also in comparing within each region patterns of residents of the primary city with residents of the remainder of the region. The data collection (by means of mail questionnaires) and analysis were carried out by the researchers.

Assistance was provided a researcher in economics in a study of the effect of soil conservation practices in several western counties of Iowa. The purpose of the project was to estimate the relationship between existing practices and the rate of soil loss due to water erosion. Field work was completed, the data processed, and consulting assistance given on the analysis of data.

A sample was designed and selected in two Iowa Communities for a project to ascertain the goals necessary to make one's community a better place in which to live. Staff members assisted in the study design, field work, and data analysis.

Off-Campus

Off-campus governmental agencies, businesses, universities, and individuals also look to the Statistical Laboratory's statisticians for consulting services. These requests are of two types: those which are arranged through a staff member directly and handled privately on the staff member's own time, and those which are channeled through the Statistical Laboratory and consulting fees paid to the university through contracts (or fees waived, depending upon the nature of the request). Some examples of university-related off-campus consulting follow:

Roy Hickman spent October 27-November 8 in Lima, Peru, consulting with staff members of the Encuesta National de Consumo de Allimentos, Romula, Grados Fuentes, concerning household surveys on food consumption under the ISU USAID/PERU Project, Iowa Universities Mission.

Paul Hinz served as a consultant to the Ministerio de Agriculture Y Cira in Marcay, Venezuela, November 25-December 5.

T. A. Bancroft is a special consultant to the West Pakistan Agriculture University on faculty appointments in the Department of Mathematics and Statistics.

Dr. Bancroft also consulted with faculty members at Montana State University and with deans from six colleges on a proposal for expanding their present statistical program to a complete statistical center at that university.

Henry B. Wallace (left in photo) of West Des Moines, Iowa, was guest of honor at the dedication ceremonies of the Henry A. Wallace Room, 319 Snedecor Hall, on October 8. Honoring the occasion of the 50th anniversary of the 1924 seminars conducted by the elder Wallace on rapid machine calculation of correlation coefficients, partial correlation and the calculation of regression lines, the Wallace Genetic Foundation donated $10,000 to equip a Snedecor Hall laboratory with 40 Monroe 900 electronic calculators.

In the photo, Iowa State University President Robert Parks visually compares one of the new calculators held by Mr. Wallace with one of the calculators used in 1924, held by Dr. H. A. David.

Current Research

Research in statistical theory and methodology is a regular activity of Statistical Laboratory staff members. Funds are made available from several resources: the budget of the Statistical Laboratory; other cooperating campus research institutes; Agriculture and Home Economics Experiment Station; and contracts and grants from governmental agencies.

All of the research reported here is a continuation of projects started in previous years.

AES Project 1806

The U. S. Census Bureau was one of the first outside agencies to enter into joint research projects with the Statistical Laboratory. Early projects included the development of sampling materials and the evaluation of procedures used in agricultural censuses. The cooperative relationship between the Census Bureau and the Statistical Laboratory has continued through a large number of projects and contracts involving questionnaire design, survey design, data collection and data analysis.

Currently, the Census Bureau's contract with the Statistical Laboratory is administered through the Agriculture Experiment Station (Project 1806). Wayne Fuller has been the principal investigator for this project for several years. During this period, the project has been primarily oriented to research in survey and measurement methods.

Objectives for this fiscal year include: (a) to consider the estimation of regression equations from data collected by sample surveys where the
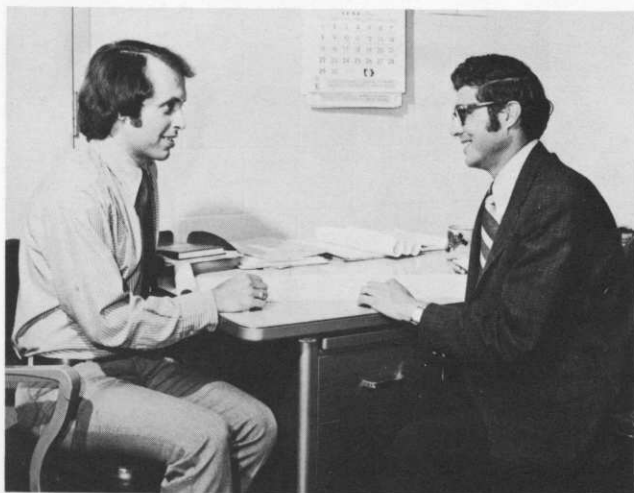
David Dickey (left), research assistant, and Dr. Wayne Fuller discuss the Census Bureau research project.

design may be other than simple random sampling; (b) to study the application of variance component models to sample data having measurement errors; (c) to formulate models and methods of estimation for data subject to response (measurement) errors and (d) to investigate the estimation of time series models, concentrating on nonstationary and noninvertible models.

Kirk Wolter, Ph.D. candidate, collaborated with Dr. Fuller during the early part of the fiscal year in research investigating estimators for a nonlinear errors-in-variables model. Some of the results of this research are outlined in Dr. Wolter's dissertation abstract located in the theses abstracts section of this report. Drs. Fuller and Wolter also prepared a manuscript, "Estimation of the Quadratic Errors-in-Variables Model" and submitted it as a report for the 1974 calendar year to the Census Bureau.

Other personnel assigned to the project are research assistants, Randy Carter and David Dickey, and Dr. Jeffery Goebel. Research in the first half of 1975 concentrated on the time series and errors-in-variables areas. Progress was made in the creation of tables to test the stationarity of autoregressive time series. A theoretical and Monte Carlo study of the instrumental variable estimator for the errors-in-variables model was conducted. In some situations it is known that the covariance between the measurement error in the dependent variable and that in the independent variable is zero. Estimators using this information were developed.

Order Statistics and Nonparametric Statistics

Dr. H. A. David, Principal Investigator of the Army Research Grant with the above title, continued work with Martin O'Connell on uses of concomitants of order statistics. The following question was studied: If an individual has rank r among n candidates in a certain test, what is the probability that he will have rank s in some future correlated test?

During the summer of 1974, Dr. Moeschberger, visiting from the University of Missouri, collaborated with Dr. David on a review of the Theory of Competing Risks. Dr. Galambos of Temple University, paying a repeat visit, investigated a variety of problems involving order statistics, particularly characterizations of probability distributions by properties of order statistics.

The Grant also supported extensive calculations, suggested by H. A. David and carried out by W. J. Kennedy and Ricky Knight, of means, variances, and covariances of order statistics in normal samples containing a single outlier differing either in mean or in variance.
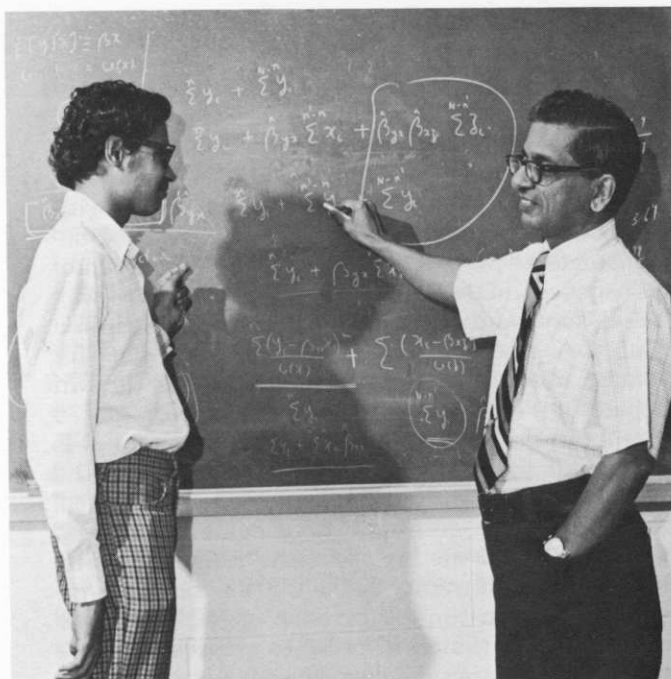
Shriram Biyani (left) is a Ph.D. research assistant supported by a grant from the U. S. Office of Education. Dr. B. V. Sukhatme (right) is assisted with his research project by Biyani and serves as Biyani's major professor.

Designing Sample Surveys and Analysis of Survey Data

Principal investigator, Dr. B. V. Sukhatme, continued research on problems in designing surveys and analysis of survey data supported by the U. S. Office of Education, Department of Health, Education and Welfare.

Further work was done on the problem of allocation in stratified sampling based on preliminary test of significance. A paper containing some of these results and written jointly with Dr. Victor K. T. Tang has been accepted for publication in the *Journal of the American Statistical Association*. Some further extensions have been included in another paper. The abstract of the paper appears elsewhere in this report.

Work also continued on the use of auxiliary data in sampling with unequal probabilities and without replacement. Several new results comparing the sampling strategies of Sampford, Goodman & Kish, and Rao, Hartley & Cochran have been obtained. These results are contained in C. Asok's Ph.D. thesis which is summarized in the publications section of this report. Papers containing these results were presented at the annual meeting of the American Statistical Association, August, 1974, and the central regional meeting of the Institute of Mathematical Statistics, March, 1975.

Mathematical and Statistical Genetics

The National Institutes of Health and the Agriculture Experiment Station Project 1669 support research in mathematical and statistical genetics under the leadership of Oscar Kempthorne and Edward Pollak. The primary objectives of this project are to develop the mathematical, probabilistic and statistical theories of genetic populations.

Dr. Kempthorne and T. H. Emigh have continued their study of the use of various theories of quantitative genetics to analyze human intelligence (as measured, for example, by I. Q.). Some basic conclusions are: (1) The use of quantitative genetic theories with I. Q. data is not justified at the present, since environments cannot be randomized with respect to genotypes and environmental effects cannot be modeled or controlled. (2) The use of the concept of heritability (the proportion of the total variance due to genotypes) is not valid if there is a covariance between environments and genotypes and if there are genotype-environmental interactions. (3) The partitioning of phenotypic variance into portions associated with variability between and within subpopulations cannot be accomplished, except under certain restrictive conditions, which do not apply to the analysis of racial differences. Research has also been done on the testing of goodness of fit of populations to the structure to be expected under the assumption of random mating.

Drs. Pollak and Barry Arnold have continued joint work on examining distributions of times spent in various states or sets of states in finite populations, where a state denotes a particular frequency of a given gene. They have also derived a formula for the covariance of the number of times pairs of frequencies are visited. This, together with known formulas for variances, allows the computation of variances of numbers of visits to sets of frequencies.

Dr. Pollak has initiated research on stochastic theory for populations with overlapping generations that are observed at times 0, 1, 2, ... Approximate formulas for survival to time t of a line of mutant genes have been obtained if t is large, both for neutral and deleterious genes and for any age of the ancestral individual. Mean frequencies at equilibrium have been computed for all age groups for a gene that is deleterious in heterozygotes if it is kept in the population by mutations arising in an exponentially growing population. Some work has also been done on a model involving two alleles in a finite haploid population with overlapping generations.

G. L. Ghai has considered a model for selection by culling in a finite haploid population; J. N.

Hansen has studied the progress of infinite populations undergoing selection by culling.

A genetic selection model which involves overlapping generations and continuous time was examined by J. L. Cornette. The effects of additive and multiplicative fertilities of mates were also examined. A large effort was directed toward the determination of conditions which imply stability of polymorphic equilibrium points when there is one locus with two alleles, random mating and additive fertilities.

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T. A. Bancroft and C. P. Han have continued their work in the area of inference for incompletely specified models involving the use of preliminary tests of significance. Two research investigations were completed which have led, in each case, to papers which have been accepted for publication:

(1) "Power of Analysis of Variance Test Procedures for Incompletely Specified Fixed Model" by Ronald Mead, T. A. Bancroft and Chien-Pai Han. Size and power of the sometimes pool test procedure in the fixed model were studied and recommendations of the levels of preliminary tests were given. The paper is based in part on some early theory developed by Bancroft and Mead's M.S. thesis (ISU, 1968) under the direction of Bancroft. It parallels the development for the random and mixed models published in the *Annals of Mathematical Statistics* (1956) and will be published in the July, 1975, issue of *Annals of Statistics*.

(2) "On Pooling Means in Multivariate Normal Distributions" by T. A. Bancroft and Chien-Pai Han. This paper is an extension to the multivariate case of the univariate case given by Kale and Bancroft (1967) *Biometrics* 23, 335-348, and has been accepted for publication in the Birthday Volume in Honor of J. Ogawa to appear in 1976.

One research investigation was completed which has led to a paper in preliminary form entitled "A Pooling Methodology for Regressions in Prediction" by J. P. Johnson, T. A. Bancroft and Chien-Pai Han. In this research the cases of pooling two or more linear regression lines and pooling two multiple regression lines were discussed. Relative efficiencies of the sometimes-pool predictor were obtained and recommendations of the levels of the preliminary tests were made. The paper is based in part on Johnson's Ph.D. thesis (ISU 1967) under the direction of Bancroft and later theoretical simplification of the results by Han which resulted in less complicated tables from which recommendations could be made.

AES Project 1753

Research in sample design and estimation techniques for soil and land use surveys was continued in the Survey Section under Agriculture Experiment Station Project 1753, directed by Roy D. Hickman. This work, conducted in cooperation with the Soil Conservation Service, USDA, included development of procedures for variance estimation of acreage estimates in cells of various two-way tables for counties, states, and the entire United States. A procedure for calculation of weights for sample observations while controlling for known population characteristics was developed, and a computer program to produce such weights was completed. Sampling procedures utilized in the 1967 Conservation Needs Inventory were reviewed, and work was initiated to compile a manual describing and listing primary sampling units selected in each county of the US for the 1967 Inventory. Some limited revision of the 1967 US sample was initiated in order to provide for more precise estimation in special soil surveys which may be desired in the future.

Samples of land were selected in 506 counties throughout the US for use in a study of potential cropland to be conducted by the SCS during 1975-76. Acreage estimates of present land use, various development problems, prime agricultural land, and potential for conversion of noncropland to cropland will be made on both a state and national basis. Another project involves the US-Canadian joint effort to study pollution in the Great Lakes region. Streambank erosion problems and their contribution to pollution in the region were investigated during a study of the Maumee River Basin, located between Fort Wayne, Indiana, and Toledo, Ohio. Several additional watersheds in the Great Lakes region are now being sampled for study during the coming year. Jeff Goebel worked closely with SCS personnel in the direction of these two projects.

Work continued on the storage, retrieval, and manipulation of the interpretive data of soil series in the United States. Soil interpretations on some 4,000 series are now on file, and the output of tabular data analyses for SCS field staff at county and state levels became an additional capability of the data system under development. These tables will become an integral part of state soil correlations in the future. A data editing and control routine for newly input interpretations is presently under development. Harvey Terpstra, who has primary direction of the soil interpretations project, continues to work closely with federal and regional center SCS personnel in the design and development of this extensive data storage and analysis system.

Professional Activities

Dr. Oscar Kempthorne, Distinguished Professor in Sciences and Humanities, was invited to participate in the P. C. Mahalanobis Memorial Symposium, "Recent Trends in Statistics," at the Indian Statistical Institute, Calcutta, India, December 16-27, 1974. He presented a paper, "Sampling Inference, Experimental Inference, and Observation Inference," on December 17.

He shared in discussion in sessions on inference, design of experiments, genetic statistics, and linguistics, and chaired a session on inference on December 27. On December 30 he contributed to a seminar, "Design of Experiments in Industry," with G. A. Barnard and G. Taguchi, for a group of industrial managers at the New Delhi Indian Statistical Institute under the auspices of the Quality Control Section of ISI.

Dr. Kempthorne was an invited member of the audience at the inauguration of the New Delhi campus of the Indian Statistical Institute performed by Mrs. Indira Gandhi, Prime Minister of India, and attended a tea with the Prime Minister after the inauguration on December 31.

January 3, 1975, he presented his Calcutta paper to the Institute of Agricultural Research Statistics at New Delhi and visited genetical workers of the Institute. On January 6 he was a guest of the Mathematics-Statistics Department of the University of Poona, headed by Dr. V. S. Huzurbazar, where he gave a seminar entitled "Best Linear Unbiased Estimation."

Edward Pollak was elected a Fellow of the American Statistical Association at the annual meeting in St. Louis, August 25-28. He was cited for his teaching of probability and statistics and for his sustained, high quality research in the mathematics, probability, and statistics of genetic systems. Bill Kennedy was elected program chairman of the Statistical Computing Section of ASA for the August '76 national meetings. During the St. Louis meeting, he was appointed chairman of the committee on methods for evaluation of numerical algorithms.

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T. A. Bancroft is included as a biographee in the 3rd edition (1977-78) of *Who's Who in the World,* published by Marquis, *Who's Who, Inc.,* Chicago.

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H. T. David has been selected as Director of the Visiting Lecturer Program of the United States statistical societies. His appointment becomes effective summer, 1975. He has been involved in the three million dollar Iowa State University Coal Research Project in a study headed by John Lemish of the Energy and Mineral Resources Research Institute. Dr. David's area of research is coal bed morphology.

Dr. Oscar Kempthorne visits with Indian Prime Minister Indira Gandhi during the tea which followed the inauguration of the New Delhi campus of the Indian Statistical Institute on December 31.

Oscar Kempthorne initiated a new chapter of Mu Sigma Rho, statistics national honorary, at Oklahoma State, October 15.

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Richard Warren is a member of the membership committee and the nomination committee for the Rural Sociological Society.

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Wayne Fuller, Roy D. Hickman, and Jeffery Goebel spent May 14-16 conferring with the Soil Conservation Service in Washington, D. C. Discussions centered around graphic, photographic, and cardiographic techniques and their possible usage as related to Soil Conservation Service work. Marjorie Mason also visited the Washington, D. C., headquarters June 8-13 to discuss and examine which Soil Conservation Service files should be retained for future use.

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Malay Ghosh chaired a session on Statistical Inference at the Eastern Regional Meeting of the Institue of Mathematical Statistics at the University of Rochester, Rochester, N. Y., May 21-23.

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Jeffery Goebel participated in a training session September 29-October 4 in Columbus, Ohio. The study involved was the Maumee River Basin Streambank Erosion Study. The design and analysis of this survey is included in the contract the Survey Unit has with the Soil Conservation Service.

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Harold Baker spent March 5 in Rochester, Minnesota, assisting in training interviewers for a study being conducted under the auspices of Mayo Clinic.

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Iowa State University Committees include Donald Hotchkiss who served as chairperson of Academic Standards and as a member of the Council on Instruction. Chien-Pai Han and H. T. David are members of the Faculty Council. Betty Ibrahim is a representative on the All-University Community Council and the Staff Council.

Papers, Lectures, and Seminars

At the summer Research Institute on Statistical Inference for Stochastic Process, Indiana University, Bloomington, August 6-9:

Bowerman, Bruce (Miami University, Oxford, Ohio): "Applications of Nonstationary Chains to Markov Decision Processes";

Isaacson, Dean: "Ergodicity of Nonstationary Markov Chains."

H. T. David chaired a session, "Stochastic Process Inference," and was a member of the planning committee.

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At the joint meetings of the American Statistical Association and the Biometric Society, St. Louis, Missouri, August 25-29:

Asok, Chaturvedula and **B. V. Sukhatme:** "On Sampford's Procedure of Unequal Probability Sampling Without Replacement";

Fuchs, Carol (Holly): "An Example of a Biased Least-Squares Estimator";

Gentle, James: "Monte Carlo Study of the Power of a Conservative Test for Outliers in the Multiple Regression Model";

Meeden, Glen and **Richard Mensing:** "Confidence Intervals Based on Grouped Data";

Wang, George, H. K., Wayne Fuller, and **Michael A. Hidiroglu:** "Estimation of Seemingly Unrelated Regression with Lagged Dependent Variables and Autocorrelated Errors."

Other staff members participated in the meetings in a variety of capacities:

C. P. Cox chaired a session, "Radioimmunoassay Statistics: Theory and Practice";

H. A. David served as chairman of the Committee on Fellows;

H. T. David chaired a session, "Goodness of Fit," and attended meetings of the *Technometrics* Management Committee;

Roy Hickman was a discussant of "An Investigation of Interview Method, Threat and Response Distortion" by William Loeander, Seymour Sudman and Norman Brodburn.

At the American Sociological Association meeting, Montreal, Canada, August, 1974:

Mulford, Charles L., Gerald E. Klonglan, **Richard D. Warren,** and David A. Hay: "Influence of Attrition Rates of Responses to Mailed Questionnaire on Measurement and Modeling";

Warren, Richard D., Gerald E. Klonglan, Judy Winkelpleck, and Steven K. Paulson: "Interorganizational Measurement: Differences Between Types of Organizations."

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At the 14th annual convention, Society for Psychophysiological Research, Salt Lake City, 1974:

Strahan, R., J. Todd, and C. Inglis: "A Measure of Palmar Sweating Specially Suited for Field Research";

Strahan, R., D. Edwards, and J. Todd: "Palmar Sweat Response to a Medical Stressor."

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At the 8th annual Symposium on the Interface, University of California, Los Angeles, February 12-14:

Sposito, V. A., Gary McCormick, and **W. J. Kennedy:** "L_1 Estimation Strategies Based on the Simplex Algorithm";

W. J. Kennedy, assisted by **James E. Gentle,** served as a workshop chairman.

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At the Midwest Sociological Society Meeting, Spring, 1975:

Schmitz, Paul F. and **Richard D. Warren:** "The Use of Multiple Regression Procedures for Cross-Validation of Sociological Variables";

Warren, Richard D. and Frederick T. Evers: "The Role of the Computer in Methods and Statistics Courses for Sociology Students";

Klonglan, Gerald E., **Richard D. Warren,** Charles L. Mulford, and Judy M. Winkelpleck: "Creating Interorganizational Measurement: Differences Between Types of Organizations."

At the joint meetings of the Biometric Society and the Institute of Mathematical Statistics, University of Minnesota, St. Paul, Minnesota, March 23-26:

Asok, Chaturvedula and **B. V. Sukhatme:** "On Rao, Hartley and Cochran's Procedure of Unequal Probability Sampling without Replacement";

Bancroft, T. A. and **C. P. Han:** "On Pooling Means in Multivariate Normal Distributions";

Chung, Richard: "A Characterization of Regular Variation by Convergence Along a Geometric Sequence";

David, H. T. and **Mohamed El Sabbagh:** "K-variate W-statistics Based on Ordered 'Distances'";

Doctor, Pamela and **H. T. David:** "Randomly Stopped Polya Urns—Estimation";

Ghosh, Malay: "Probabilities of Moderate Deviations for Some Stationary Processes";

Meeden, Glen: "Bayes Estimation of the Mean and Other Functions in the Exponential Family";

Talwar, Prem and **James Gentle:** "Robust Tests for the Homogeneity of Variances."

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Bancroft, T. A.: "The Dual Nature of Statistics and the Role of a Complete Statistical Center in a Large University," and "Testimating, Testipredicting, and Testitesting as Aids in the Use of Snedecor and Cochran's *Statistical Methods*," Montana State University, Bozeman, Montana, February 3.

Coveyou, Michael: "Ideology and the Quality of Anglo-American Party Imagery," at the meeting of the American Political Science Association, Chicago.

David, H. A.: "Some Uses of Order Statistics," at the 20th conference on the Design of Experiments in Army Research, Fort Belvoir, Virginia, October 22-25;
"Concomitants of Order Statistics," seminar, University of Iowa, April 3; University of Missouri, Columbia, April 10; Hebrew University, Jerusalem, Israel, June 2.

Dr. Glen Meeden (left) and Dr. Malay Ghosh collaborated on several research projects during the year.

Ghosh, Malay: "Asymptotic Normality of Stopping Times in Sequential Estimation," seminar, University of Minnesota, December 5; Purdue University, February 26;
"How Many Tosses of the Coin?" seminar, North Carolina State University, February 20;
"Sequential Rank Tests for Regression," at the Eastern Regional meeting of the Institute of Mathematical Statistics, University of Rochester, Rochester, New York, May 21;
"Bivariate Sequential Point Estimation," seminar, Department of Mathematics, Universite de Montreal, May 28.

Smith, Joan K. and Roy D. Hickman: "The Impact of a Foundations Course on Attitudes: Results of a Longitudinal Study," at the American Educational Studies Association, New York, New York, November 2.

Kempthorne, Oscar: "The Nature and Scope of Statistical Methods," seminar, Simon Fraser University, British Columbia, July 26;
"Inference from Experiments and Randomization," seminar, Oklahoma State University, October 15;
"IQ and Heredity," seminar, Harvard University, March 27;
"Experimental Inference," seminar, University of Northern Iowa, Cedar Falls, under auspices of Visiting Lecturer Program of the Institute of Mathematical Statistics, May 7.

Meeden, Glen: "Choosing a Prior for a Binomial Testing Problem with Incomplete Knowledge," at a regional research conference on Nonparametric Decision Theory, Columbus, Ohio, July 8-12;
"Bayes Estimation of the Mean and Other Functions in the Exponential Family," at the annual meetings of the Institute of Mathematical Statistics and Directions for Mathematical Statistics, Edmonton, Alberta, Canada, August 12-16.

Pollak, Edward: "A Stochastic Theory for Rare Genes in Large Populations with Overlapping Generations," at the spring meeting of the Iowa section of SIAM, Iowa City, April 5.

Strahan, R. F., J. B. Todd, and G. B. Inglis: "A Simple New Measure of Palmar Sweating," at the 46th annual convention, Midwestern Psychological Association, Chicago, 1974.

Sukhatme, B. V.: "Preliminary Testing and Allocation in Stratified Sampling," seminar, Department of Statistics, University of Waterloo, Waterloo, Canada, June 20, 1974;
"Preliminary Testing and Designing of Surveys," seminar, Department of Mathematics, Carlton University, Ottawa, Canada, June 24, 1974.

Warren, Richard D. and Frederick T. Evers: "The Farmer Cooperative: A Formal Organization," at a meeting of the Rural Sociological Society, McGill University, Montreal, Canada, August, 1974.

Warren, Richard and **Roy Hickman:** "Costs and Benefits of Alternative Data-Gathering Techniques," at the conference on Alternative Methods for Public Policy Research in Rural America, Iowa State University, Spring, 1975.

Publications and Theses Abstracts

Published Research

Statistical Laboratory staff members frequently have their research results published in professional journals or as conference proceedings from papers they have presented. They also serve in various professional roles relating to publication of journals. C. P. Han was appointed to the editorial board of *Communications in Statistics*. Wayne Fuller is an associate editor of the *Journal of the American Statistical Association*. Oscar Kempthorne is an associate editor of *Biometrics* and *Theoretical Population Biology*. Drs. Kempthorne and T. A. Bancroft are members of the editorial advisory board for the *Journal of Statistical Computation and Simulation*. Dr. Bancroft is a reviewer for *Mathematical Reviews* published monthly by the American Mathematical Society. H. T. David is a member of the management committee of *Technometrics*.

Abstracts and papers published by staff members and graduate students, theses abstracts, and books reviewed during the fiscal year 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 (*).

Arnold, Barry: "Multivariate Exponential Distributions Based on Hierarchical Successive Damage," *Journal of Applied Probability* 12:1 (1975) 142-147. SLRS 358.

A class of multivariate exponential distributions is suggested which includes those presented by Marshall and Olkin, Downton, and Hawkes. It is based on a concept of hierarchical successive damage. Recursive expressions for the Laplace transforms and for first and second moments are derived in the bivariate case. Related multivariate geometric distributions are described.

Arnold, Barry: "On Estimates of the Smaller of Two Ordered Normal Means Which Incorporate a Preliminary Test of Significance," *Utilitas Mathematica* 5 (1974) 65-74. SLRS 347.

Two samples are available from normal populations with means μ_1 and μ_2. It is assumed known that $\mu_1 \leq \mu_2$, and it is desired to estimate μ_1. It is demonstrated that, in both the known variances case and the unknown but equal variances case, certain estimates incorporating natural preliminary tests of equality of μ_1 and μ_2 are uniformly better in the sense of having uniformly smaller mean squared error. This phenomenon is observed provided that the preliminary test is of size at least 0.50. The optimal estimate within this class is that corresponding to size 0.50. This estimate coincides with the first coordinate of the maximum likelihood estimate of (μ_1, μ_2) (equivalent in this case to the isotonic regression estimate).

Arnold, Barry and *Glen Meeden:* "Characterization of Distributions by Sets of Moments of Order Statistics," *Annals of Mathematical Statistics* 3:3 (1975) 754-758. SLRS 354.

It is known that the set $M = [\mu_{r,n}: r = 1,2,\ldots,n; n = 1,2,3,\ldots]$ of expectations of order statistics of samples from a distribution F completely determines F. In addition it is known that certain subsets of M also determine F. In this note conditions are derived which are sufficient for a proper subset of M to determine F.

Arnold, Barry C. and *Richard Groeneveld:* "Bounds for Deviations Between Sample and Population Statistics," *Biometrika* 61:2 (1974) 387-389. SLRS 340.

A number of bounds on the maximum deviation between parameters of a finite population and their corresponding sample estimates are found by exploiting a theorem from regression analysis.

Asok, Chaturvedula and *B. V. Sukhatme:* "On Sampford's Procedure of Unequal Probability Sampling without Replacement," *Proceedings of the Social Statistics Section, American Statistical Association*, 1974, 220-225. SLRS 349.

Among the schemes available for $n \geq 2$ those suggested by Goodman and Kish (G. K.) (1950) and

Sampford (1967) are relatively simple to adopt besides satisfying the condition $\pi_i = np_1 \leq 1$. Hartley and Rao (1962) used an asymptotic approach to derive the variance of the Horvitz-Thompson (H. T.) estimator of the population total for G. K. procedure. Rao (1965) has shown by the same approach that the variance to $O(N^1)$ of the H. T. estimator for either of the schemes of Brewer (1963), Rao (1965), and Durbin (1967) is the same as that for G. K. procedure; and to $O(N^\circ)$, the variance for either of the above three schemes is smaller than that for G. K. procedure.

Here it is proved that the variance to $O(N^1)$ of the H. T. estimator for Sampford's procedure is the same as that for G. K. procedure, and the variance to $O(N^\circ)$ for Sampford's procedure is smaller than that for G. K. procedure. This generalizes the result of Rao since Sampford's procedure is a generalization of the procedures of Durbin and Rao for $n > 2$.

*Bancroft, T.A.: "Testimating, Testipredicting, and Testitesting as Aids in Using Snedecor and Cochran's *Statistical Methods,*" *Biometrics* 31:2 (1975) 319-323. SLRS 359.

Three separate inference procedures, each incorporating a preliminary test of significance, are discussed as aids in using Snedecor and Cochran's *Statistical Methods.* For each situation involving some uncertainty regarding a proper model specification, it is shown how to resolve the particular uncertainty by using a preliminary test of significance in accordance with the recommendations given in the referenced publication. These problems fall in the general area of inference for incompletely specified models incorporating a preliminary test of significance.

Garcia, Pilar A., **George E. Battese** (Department of Economic Statistics, University of New England, Armidale, Australia), and Wilma D. Brewer: "Longitudinal Study of Age and Cohort Influences on Dietary Patterns," *Journal of Gerontology* 30:3 (1975) 349-356. Journal Paper No. J-7645, Iowa Agriculture and Home Economics Experiment Station, Project No. 1965.

Dietary data from weighed food intake records were obtained from 35 women 29 years old and older during 4 studies from 1948 to 1966. Longitudinal data were analyzed by the use of a multiple linear-regression model with year of birth and age as independent variables. With increasing age, mean intakes declined significantly for fat, saturated fatty acids, and oleic acid, and increased significantly for calcium. After accounting for cohort effects, no significant changes occurred in mean intakes of food energy, carbohydrate, protein, phosphorus, iron, thiamin, riboflavin, preformed niacin, vitamin A, and ascorbic acid. For successive year of birth, mean intakes increased significantly for protein, calcium, phosphorus, riboflavin, preformed niacin, and linoleic acid. The regression model used explained approximately 20% of the variability in intakes of food energy and most nutrients examined.

Guthrie, W. D., Y. S. Rathmore, **D. F. Cox** and G. L. Reed: "Europeon Corn Borer: Virulence on Corn Plants of Larvae Reared for Different Generations on a Meridic Diet." *Journal of Economic Entomology* 56 (1974) 605-606.

*David, H. A.: "Parametric Approaches to the Theory of Competing Risks," 275-290. In: F. Proschan and R. J. Serfling (editors) *Reliability and Biometry*, SIAM, Philadelphia, Pa., 1974. SLRS 336.

Suppose that, for a certain population, causes of death are grouped into k classes. Each member of the population is then subject to k risks 'competing for his life.' The theory of competing risks (or multiple decrement) is concerned with assessing the importance of the k causes which are usually assumed to act independently. One question of special interest is: If a certain cause of death is eliminated or changed in importance, what will be the effect on the mortality pattern of the population?

With a slight change of emphasis the theory applies equally to a system in a life-test subject to k causes of failure.

The theory is reviewed and some recent developments are indicated. Special attention is paid to the case when the k competing risks are dependent in the manner of the Marshall-Olkin model.

*David, H. A. and **J. Galambos** (Temple University, Philadelphia, Pennsylvania): "The Asymptotic Theory of Concomitants of Order Statistics," *Journal of Applied Probability* 11:4 (1974) 762-770. SLRS 355.

In a random sample of n pairs $(X_r, Y_r), r = 1, 2, \ldots, n$, drawn from a bivariate normal $N(\mu_x, \mu_y, \sigma_x^2, \sigma_y^2, \rho)$ distribution, let $X_{r:n}$ be the rth order statistic among the X_r and let $Y_{[r:n]}$ be the Y-variate paired with $X_{r:n}$. The $Y_{[r:n]}$ which we call concomitants of the order statistics, arise most

naturally in selection procedures based on the $X_{r:n}$. It is shown that asymptotically the k quantities $Y^*_{[r_i:n]} = Y_{[r_i n]} - E(Y_{[r_i:n]})$ $i = 1,2,...,k; 1 \leq r_i < r_2 < ... < r_k \leq n$; k fixed, are independent, identically distributed $N(0, \sigma_y^2 (1 - \rho^2))$ variates. In addition, putting $R_{t,n}$ for the number of integers j for which $Y_{[t:n]} \geq Y_{[j:n]}$, the asymptotic distribution and all moments of $n^{-1}R_{t,n}$ are determined for t such that $t/n \rightarrow \lambda$ with $0 < \lambda < 1$.

*Fuller, Wayne A. and George E. Battese (Department of Economic Statistics, University of New England, Armidale, Australia): "Estimation of Linear Models with Crossed-Error Structure," *Journal of Econometrics* 2 (1974) 67-68. SLRS 337.

Sufficient conditions are presented under which the generalized least-squares estimator, with estimated covariance matrix, is unbiased for the parameters in the crossed-error model and has the same asymptotic distribution as the generalized least-squares estimator. The model permits the presence of independent variables that are constant over cross sections or time periods. The model does not require that the variance components associated with cross sections or time periods be positive.

*Ghai, G. L. (Department of Mathematical Sciences, Florida International University, Miami): "Analysis of Some Nonrandom Mating Models," *Theoretical Population Biology* 6:1 (1974) 76-91. Journal Paper No. J-7297, Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, Project 1669; partial support by National Institutes of Health, Grant No. 13827. SLRS 344.

In this paper a few asymmetric models are presented taking account of the effects of assortative mating on an autosomal trait controlled by a single locus possibly with multiple alleles. The models are developed by specifying the intensities for preference mating for various phenotypes. The analysis is confined to the case in which preference is exercised by the individuals of one sex only. It is assumed that males possess unlimited fertility.

The dynamics of the population and its equilibrium distribution are discussed. The gene frequency usually changes with time, and equilibrium distribution in most cases depends only on the assortment parameters. Expressions are obtained giving the additive and dominance components of variance, and covariances for relatives for populations in equilibrium for some of the models.

Sen, Pranab Kumar and Malay Ghosh: "Some Invariance Principles for Rank Statistics for Testing Independence," *Z. Wahrscheinlichkeitstheorie and Verwandte Gebiete* 29 (1974) 93-108.

In the context of testing the hypothesis of stochastic independence, along with a martingale property of a class or rank order statistics, a functional central limit theorem, an almost sure (a.s.) invariance principle and a law of iterated logarithm for such statistics are established. Almost sure convergence of these statistics to appropriate centering constants is also proved under weaker regularity conditions. These results are then incorporated in the study of the asymptotic theory of some sequential tests for independence.

Ghosh, Malay: "Probabilities of Moderate Deviations Under m-Dependence," *Canadian Journal of Statistics* 2:2 (1974) 157-168.

Consider a stationary sequence $[X_1, X_2,...]$ of m-dependent random variables. It is proved that for any constant $c > 0$, if $E|X_1|^p < \infty$ for some $p > c^2 + 2$, then $P[n^{-1} \sum_1^n (X_i - \mu) > cA(\log n/n)^{1/2}] \sim (c^2 2\pi \log n)^{-1/2} n^{-1/2 c^2}$

and

$P[| n^{-1} \sum_1^n (X_i - \mu)| > cA(\log n/n)^{1/2}]$

$2(c^2 2\pi \log n)^{-1/2} n^{-1/2 c^2}$,

as

$n -> \infty$, where $\mu = E(X_1)$, $A^2 = V(X_1) + 2 \sum_{j=1}^m$ Cov. (X_1, X_{1+j}).

The above results on probabilities of moderate deviations for sample means are then used to obtain similar results for U-statistics and Von Mises' differentiable statistical functions when the underlying variables form a stationary m-dependent sequence.

Ghosh, Malay: "On Some Properties of a Class of Spearman Rank Statistics with Applications," *Annals of the Institute of Statistical Mathematics* 27:1 (1975) 57-68.

The present paper studies some properties of a class of Spearman rank statistics and applies these results in proving certain "optimality" properties of a proposed sequential bounded length confidence interval procedure for simple regression coefficients in linear models where both variables are subject to error. It is shown that the proposed procedure is asymptotically consistent and efficient in the sense of Chow and Robbins.

Sen, Pranab Kumar and **Malay Ghosh:** "Sequential Rank Tests for Location," *The Annals of Statistics* 2:3 (1974) 540-552.

In this paper, for the one and two sample location problems, a class of sequential tests based on robust rank order statistics is developed. The proposed tests terminate with probability one for square integrable score functions. Under more stringent regularity conditions and for local alternatives, the OC and ASN of the proposed tests are obtained, and the allied asymptotic relative efficiency results with respect to the sequential probability ratio and likelihood ratio tests are studied.

***Grimes, J. E.** (California Polytechnic State University, San Luis Obispo) and **B. V. Sukhatme:** "A Regression-type Estimator Based on Preliminary Test of Significance," *Proceedings of the Social Statistics Section, American Statistical Association,* 1973. SLRS 334.

If data on an auxiliary variable X is available, regression-type estimators are generally used to estimate the population mean $\bar{Y}$. One such estimator is the difference estimator $\bar{y}_d$ which requires knowledge of β, the regression coefficient of Y on X. If β is not known, $\bar{Y}$ is estimated by the usual regression estimator $\bar{y}_1$ based on the sample regression coefficient. $\bar{y}_1$ is in general biased and less efficient than $\bar{y}_d$. It is often possible to make an intelligent guess of β, say β_0. If the guess is correct, $\bar{y}_d$ is an appropriate estimator, otherwise $\bar{y}_1$ may be more appropriate. Before deciding on the estimator, it is therefore proposed to test the hypothesis $\beta = \beta_0$. If the hypothesis is rejected, $\bar{Y}$ is estimated by $\bar{y}_1$. The paper derives the mean square error of the proposed regression-type estimator and investigates its efficiency with respect to other regression-type estimators.

***Han, Chien-Pai:** "Some Relationships Between Noncentral Chi-squared and Normal Distributions," *Biometrika* 62:1 (1975) 213-214. SLRS 352.

Cumulative distribution functions of noncentral chi-squared distributions with odd degrees of freedom are expressed as functions of the distribution function and probability density function of the standard normal distribution. From these relationships, the probabilities can be easily computed.

***Han, Chien-Pai:** "Asymptotic Distribution of Discriminant Function When Covariance Matrices Are Proportional and Unknown," *Annals of Institute of Statistical Mathematics,* 26 (1974) 127-133. SLRS 335.

Let $\underline{X}_{pxl}$ be an observation to be classified into one of two p-variate normal populations denoted by π_1: $N(\underline{\mu}_1, \underline{\Sigma})$ and π_2: $N(\underline{\mu}_2, \sigma^2 \underline{\Sigma})$, $\sigma^2 > 1$. In this paper, it is assumed that μ_1 and μ_2 are unknown and the covariance matrices are partially known, i.e. either σ^2 is known or $\underline{\Sigma}$ is known. Suppose a random sample of size n_i is taken from π_i, i = 1, 2, discriminant functions are derived by using the likelihood ratio procedure and substituting unknown parameters by their estimators under the two cases: (1) σ^2 is known and Σ unknown, (2) σ^2 unknown and Σ known. The asymptotic expansion of the distributions of discriminant functions for the two cases are obtained by the "studentization" method up to the first order with respect to the sample sizes.

***Lauer, G.N.** and **Chien-Pai Han:** "Power of Cochran's Test in the Behrens-Fisher Problem," *Technometrics* 16 (1974) 545-549. SLRS 343.

This paper investigates the test of equality of means in the Behrens-Fisher problem proposed by Cochran (see Cochran and Cox, *Experimental Designs,* Wiley, 1957, p. 101; and Cochran, 1964, *Biometrics* 20, 191-195). Size and power characteristics are studied and compared to the test developed by Banerjee, 1960, *Sankhya* 22, 357-358, and McCullough et. al., 1960, *Biometrika* 47, 345-353. Consideration is also given to the problem of testing means subsequent to a preliminary test of equality of variances. Size and power is studied numerically and recommendations for choosing the level of the preliminary test are given. A numerical example is given to illustrate its use.

***Hill, William G.** (Institute of Animal Genetics, Edinburgh, Scotland): "Disequilibrium among Several Linked Neutral Genes in Finite Population. I. Mean Changes in Disequilibrium," *Theoretical Population Biology* 5:3 (1974) 366-392. Journal Paper No. J-7541, Iowa Agriculture and Home Economics Experiment Station, Project 1669; partial support by National Institutes of Health, Grant No. GM-13827. SLRS 339.

Formulae are developed for computing changes in expected values in a finite population of linkage disequilibrium among neutral genes from more than two loci, although the exact analysis is taken up to only six loci. An essentially haploid model is used. As with two loci, the three-locus disequilibrium declines exponentially at all generations, but for $m > 3$ loci a matrix has to be constructed to give joint changes in the m-locus disequilibrium and products of disequilibria with fewer loci, for example of two m/2-locus disequilibria. The asymptotic rates of change in multilocus disequilibria depend on the arrangement of genes on the chromosome as well as its total length, but the initial rate of breakdown of disequilibrium from a line cross base is less dependent on the arrangement. With equally spaced loci the asymptotic rate of breakdown of m locus disequilibrium is roughly proportional to m. Although mutation and interference are excluded from the main analysis, it is shown how they can be incorporated.

*Hill, William G.: "Disequilibrium Among Several Linked Neutral Genes in Finite Population. II. Variances and Covariances of Disequilibria," *Theoretical Population Biology* 6:2 (1974) 184-198. Journal Paper No. J-7647, Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, Project 1669; partial support by National Institutes of Health, Grant No. GM-13827. SLRS 345.

A method is derived for computing the variances and covariances of linkage disequilibria between neutral genes in finite populations, which is based on a linear transformation of results given previously for the mean values of disequilibria. The formulae obtained are limited to moments of sixth order or lower, such as the variance of the three-locus disequilibrium. It is shown that there is no covariance between any pair of disequilibria in populations starting equilibrium. The pattern of change with time in variance of the three-locus disequilibrium from populations initially in equilibrium is similar to that for two loci, except that the highest values are achieved earlier and are smaller.

Schmitt, D. P., D. C. Norton and P. Hinz: "Control of Meloidogyne Hapla on Peony," *Plant Disease Reporter* 58 (1974) 860-864.

Up to 94% control of *Meloidogyne hapla* in *Paeonia lactiflora* "Mons Jules Elie" was obtained by planting crown divisions in fumigated soil when followed by annual sidedressings of systemic or contact nematicides. Plants from hot water-treated crown divisions had little root knot, but they generally were stunted and produced fewer flowers than did plants from divisions that were not hot water-treated. Plants grown from untreated crown divisions had the highest root-knot index.

Wright, Earl O. and Donald K. Hotchkiss: "A Research Note: Preliminary Study to Determine the Feasibility of Using a 0.20-inch Diameter Disk to Measure Sediment in Fluid Milk," *Journal of Milk and Food Technology* 37:8 (1974) 409-410.

A preliminary collaborative study was done to determine whether laboratory personnel could grade raw milk for sediment content using 0.20-inch diameter as well as 0.40-inch diameter sediment disks. The 0.40-inch disk presently is used for grading sediment in mixed bulk milk samples. Technicians in 10 separate laboratories made 800 determinations (80 per laboratory) of known sediment amounts on 0.20-inch and 0.40-inch diameter standard sediment disks; 225 (63.7%) of 400 determinations made on the 0.20-inch diameter disk were graded accurately, whereas 187 (46.8%) of the 400 determinations made on the 0.40-inch diameter sediment disks were graded correctly. Based on these results, it is recommended that photoprint standards be developed for 0.20-inch diameter sediment disks and that a further collaborative study be undertaken.

E. A. Foda, E. G. Hammond, G. W. Reinbold, and D. K. Hotchkiss: "Role of Fat in the Flavor of Cheddar Cheese," *Journal of Dairy Science,* 57 (1974) 1137-1142.

The flavor of Cheddar cheese made from various kinds of fats homogenized into skim milk was compared with cheese made from natural milk emulsion. Milk fat homogenized into skim milk gave better flavors than other fats but was inferior to the natural milk emulsion. Commercial fats with composition and physical properties similar to milk fat seemed to give off-flavors during cheese ripening and performed less well than an inert mineral oil. Deodorized milk fat was not significantly different from milk fat in flavor production. Adding dimethyl sulfide and milk-fat-globule membrane material did not significantly improve cheese flavor. The addition of gum acacia as an emulsifying agent made the flavor more Cheddar-like, indicating that the water-fat interface is important in development of Cheddar flavor.

Huntsberger, David V., Patrick Billingsley, and D. James Croft: *Statistical Inference for Management and Economics,* Allyn and Bacon, Inc., Boston, 1975, 507 pages.

Designed for the undergraduate business student with no previous statistical background and a minimum knowledge of mathematics, this text presents basic statistical techniques for a one-semester or two-quarter course. A primary objective of the book is to allow students an opportunity to understand the reasons underlying these techniques rather than learn statistical methods by rote.

The book also provides a base from which the student can proceed to more advanced work, including specialized applications. Chapters 1-8 are designed to be studied in sequence and provide the basis for an elementary understanding of business statistics. The remainder of the book (Chapters 9-17) provides much flexibility in selection of material which varies in difficulty to meet the interests and diversity of students and instructors.

Isaacson, Dean L. and Richard W. Madsen: "L_1 Ergodic Behavior of Non-Negative Kernels," *Israel Journal of Mathematics* 17:4 (1974) 350-363.

Some results that have been obtained in the study of strongly and weakly ergodic behavior of non-homogeneous stochastic kernels are generalized to the case of non-negative kernels. The first generalization simply involves extending the definitions of weakly and strongly ergodic behavior to the case of non-negative kernels and using the ergodic coefficient which was first defined for stochastic kernels by Dobrushin and extended to non-negative kernels by Blum and Reichaw. It happens that this straightforward extension excludes many cases of non-negative kernels which do exhibit a type of ergodic behavior. In order to study these cases, a definition of L_1 weakly and strongly ergodic behavior is given in which normalizing by constants is allowed. Sufficient conditions for these types of ergodic behavior are given.

Isaacson, Dean and Richard Madsen: "Positive Columns for Stochastic Matrices," *Journal of Applied Probability* 11:4 (1974) 829-835.

If an n x n stochastic matrix has a column with no zeros, one can immediately conclude that the chain is ergodic and the state corresponding to that column is persistent and aperiodic. In this paper it is shown that it is decidable whether or not some power of a finite stochastic matrix has a positive column. Some problems regarding positive columns in infinite stochastic matrices are also considered.

*Kempthorne, Oscar: "Inference from Experiments and Randomization," pp 303-331, In: J. N. Strivastava (editor) *A Survey of Statistical Design and Linear Models,* North-Holland Publishing Company, 1975. Journal Paper No. J-7637, Iowa Agriculture and Home Economics Experiment Station, Project 890; partial support by National Science Foundation, Grant No. GP-24614. SLRS 351.

*Meeden, Glen: "Choosing a Prior for a Binomial Testing Problem with Incomplete Knowledge," *Journal of the American Statistical Association* 69:347 (1974) 740-743. SLRS 342.

Let X be binomial (n,p), with n known. Suppose we wish to test H: p = 1/2 against K:p $\neq$ 1/2. We consider the problem of choosing a prior distribution for p. Using a theory which introduces certain ideas of the Neyman-Pearson approach to Bayesian testing, it is shown that one need not specify a prior exactly, but only an equivalence class of priors. The equivalence class of the uniform prior over K allows us to specify certain situations involving only partial knowledge about the parameter in which one can use the uniform as the appropriate prior.

*Pollak, E.: "Survival Probabilities and Extinction Times for Some Multitype Branching Processes," *Advances in Applied Probability* 6:3 (1974) 446-462. Journal Paper No. J-7701, Iowa Agriculture and Home Economics Experiment Station, Project No. 1669; partial support by National Institutes of Health Grant No. GM-13827. SLRS 341.

This paper deals with the computation of survival probabilities and extinction times for multitype positively regular branching processes. If all of the generating functions of the offspring distributions are of the linear fractional form and have the same denominator, explicit expressions may be obtained for all of their iterates. It is then possible to obtain formulae for survival probabilities and bounds on the mean time to extinction, given extinction, of a line descended from a single individual. If there are two types and the offspring distributions are bivariate Poisson, their generating functions may be bounded by linear fractional generating functions. It is then possible to compute upper and lower bounds on mean times to extinction, given extinction, and this is done for some special cases.

*A. B. Chia and **Edward Pollak:** "The Inbreeding Effective Number and the Effective Number of Alleles in a Population that Varies in Size,"

Theoretical Population Biology 6:2 (1974) 149-172. Journal Paper No. J-7353, Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, Project 1669; partial support by National Institutes of Health, Grant No. GM-13827. SLRS 346.

Consider a population that does not change in size. If it is assumed that there are an infinite number of possible neutral alleles at a locus and u is the probability that a particular gene mutates to some other gene in one generation, the effective number of alleles n_e, is computed to be $4 N_e u + 1$, where N_e is the inbreeding effective population number. It is assumed in this paper that the number of individuals in a monoecious population or the numbers of males and females in a dioecious population are states in a finite reducible Markov chain. In general it is impossible to obtain a single value of n_e. In some cases where the computation of n_e is possible, the results are as follows: When the population is monoecious, N_e is the reciprocal of the asymptotic average over population sizes of the probabilities that two gametes uniting to form an individual came from the same individual one generation earlier. In dioecious populations, N_e is the reciprocal of the long-run average of the probabilities that two homologous genes in separate individuals of one generation came from the same individual one generation earlier. Special cases are discussed.

*Roux, C. Z. (Animal and Dairy Science Research Institute, Pretoria, South Africa): "Hardy-Weinberg Equilibria in Random Mating Populations," *Theoretical Population Biology* 5:3 (1974) 393-416. Journal Paper No. J-6805, Iowa Agriculture and Home Economics Experiment Station, Project 1669; partial support by National Institutes of Health, Grant No. GM-13827. SLRS 338.

The structure of multiloci random mating populations is examined. Sufficient conditions for the existence of stable local Hardy-Weinberg equilibria for n loci and an arbitrary number of alleles per locus, are then derived for specified situations under the assumption of multiplicative gene action between loci. It is shown that a stable Hardy-Weinberg equilibrium cannot be a local maximum of the mean fitness function with multiplicative gene action between loci. The stability of Hardy-Weinberg type border points and the condition for the increase of newly introduced genes are topics on which some n-loci results are also obtained for an arbitrary number of alleles per locus in systems that allow Hardy-Weinberg equilibria.

Hall, Harry H., Earl O. Heady, Arthur L. Stoecker, and **Vincent A. Sposito:** "Quadratic Programming of Spatial Equilibrium," pp. 420-451. In: E. O. Heady and U. K. Srivastina (editors) *Spatial Sector Programming Models in Agriculture.* Iowa State University Press, Ames, Iowa. 1975.

Hall, H. H., E. O. Heady, A. Stoecker, and **V. A. Sposito:** "Spatial Equilibrium in U. S. Agriculture: A Quadratic Programming Analysis," *SIAM Review* 17:2 (1975) 323-337.

A spatial competitive equilibrium for the crop and livestock sectors of the U. S. agricultural economy is approximated. Agricultural commodities are classified into three mutually exclusive classes: primary, intermediate, and desired. Primary commodities represent available resources; intermediate commodities are produced only as inputs for further production; desired commodities are wanted either for consumption or for other uses outside the system (export). The 48 contiguous states and the District of Columbia are partitioned into 10 markets, which are further partitioned into a total of 103 crop producing regions. In each market, demands for 10 desired commodities are represented by functions, linear in commodity prices. Production of crops and livestock and intermarket commodity shipments are represented by linear activities. The objective function maximizes aggregate producer profits. Since the demand functions are linear, total revenue is quadratic in the prices of desired commodities, hence the quadratic programming formulation. In the results, estimated prices for desired commodities are lower than observed prices and, with minor exceptions, estimated quantities exceed observed quantities.

Sposito, V. A., Gary F. McCormick and **W. J. Kennedy:** "L_1 Estimation Strategies Based on the Simplex Algorithm," *Proceedings of Computer Science and Statistics*, 242-247.

In this paper it is shown that a modification of Barrodale and Young's original algorithm for L_1 estimation which uses the median of the positive quotients can result in a problem which will cycle. Moreover, a simulation study is given which investigates the optimal number of iterations to use the median of the positive quotients before switching back to Barrodale and Young's algorithm. These results are compared to Barrodale and Roberts' improved algorithm.

*Sposito, V. A.: "Modified Regularity Conditions for Nonlinear Programming Problems Over Mixed Cone Domains," *Mathematical Programming* 6 (1974) 167-179. SLRS 332.

In earlier results by Sposito and David, Kuhn-Tucker duality was established over nondegenerate cone domains (not necessarily polyhedral) without differentiability under a certain modification of Slater's Condition, in addition to the convexity of a certain auxiliary set. This paper extends Kuhn-Tucker duality to optimization problems with both nondegenerate and degenerate cone domains. Moreover, under a different condition than presented in earlier results by the author, this paper develops Kuhn-Tucker duality for a certain class of nonlinear problems with linear constraints and an arbitrary objective function.

Trzeciak, J. M., and **V. A. Sposito:** "A Geometric Programming Decomposition Procedure," *Journal of ASME* 97:B:1 (1975) 371-373.

A decomposition procedure is given which will decompose any non-classical geometric programming problem into a classical (monomial) geometric programming problem. Moreover, it is shown that the monomial geometric programming problem can be solved by linear programming techniques.

Strahan, Robert: "Situational Dimensions of Self-Reported Nervousness," *Journal of Personality Assessment* 38:4 (1974) 341-352.

Endler, Hunt, and Rosenstein's systematic application of the stimulus-response model in their psychometric study of anxiety provided the impetus and rationale for this work, investigation of the situational dimensions of self-reported nervousness. Factor analysis of a nervousness inventory revealed three broad dimensions, characterized by social situations, situations of physical discomfort or potential bodily harm, and situations of disorder or disruption. The first two of these dimensions have been observed before. The thrid has not been conspicuously noted and may especially merit further study.

Strahan, Robert: "Development of a Personality Test Based on General Fund of Information," *Journal of Personality Assessment* 38:3 (1974) 215-222.

The preliminary development of a personality test, the Zax Information Profile (ZIP) involving 24 content areas , is described. Measures of internal consistency of the items in the separate sub-tests are reported as well as the factor structure of the test with reference to several different *S* samples. Although internal consistency measures are not as high as were hoped for, they are consistent with similar measures done on somewhat similar test instruments. Furthermore, an external validation study demonstrated that the test differentiated very effectively between music students and arts college students in the predicted directions. The potential use of the test as a screening device for entering college students and as an instrument for providing leads for constructing optimal housing arrangements and programs to prevent social maladjustment in college students is discussed.

Singh, Ravindra and **B. V. Sukhatme:** "Optimum Stratification with Ratio and Regression Methods of Estimation," *Annals of the Institute of Statistical Mathematics* 25 (1973) 627-633.

The paper considers the problem of optimum stratification on an auxiliary variable x when the information on the auxiliary variable x is also used to estimate the population mean $\bar{Y}$ using ratio or regression methods of estimation. Assuming the form of the regression of the estimation variable y on the auxiliary variable x as also the form of the conditional variance function $V(y|x)$, the problem of determining optimum strata boundaries (OSB) is shown to be a particular case of optimum stratification on the auxiliary variable for stratified simple random sampling estimate. A numerical investigation has also been made to study the amount of gain in efficiency that can be brought about by stratifying the population.

*Sukhatme, B. V. and Victor K. T. Tang: "Allocation in Stratified Sampling Subsequent to Preliminary Test of Significance," *Journal of the American Statistical Association* 70:349 (1975) 175-179. SLRS 356.

A procedure for allocation of sample sizes to different strata consists of drawing a preliminary sample of fixed size from each stratum to estimate the strata variances and test their homogeneity. If the strata variances are found homogeneous, the sample sizes to be drawn from different strata are allocated according to proportional allocation; otherwise, they are allocated according to Neyman allocation using estimated variances. The efficiency of the proposed allocation, based on preliminary test of significance with respect to proportional allocation and modified Neyman allocation, is investigated.

*Tang, Victor K. T. and **B. V. Sukhatme:** "Use of Preliminary Test of Significance for Allocation in Stratified Sampling," *Journal of the Indian Statistical Association* 10 (1972) 100-114. SLRS 331.

Sukhatme and Tang (1970) proposed an allocation based on preliminary test of significance and discussed its efficiency with respect to proportional allocation and modified Neyman allocation for the case of two strata. This paper considers the case when $\sigma_1^2 \leq \sigma_2^2 \leq \sigma_3^2$ and indicates how the results can be extended to any number of strata.

*David, Isidoro P. and **B. V. Sukhatme:** "On the Bias and Mean Square Error of the Ratio Estimator," *Journal of the American Statistical Association* 69:346 (1974) 464-466. SLRS 333.

In deriving the bias and mean square error of the ratio estimator $\hat{R} = \bar{y}/\bar{x}$, it is generally assumed that $|\bar{x} - \bar{X}| < \bar{X}$ for all possible samples. This assumption is, however, unlikely to be satisfied except in special situations. This article presents a justification for the use of the usual approximations to the bias and mean square error of $\hat{R}$. Bounds for the deviations of the approximations from the true values are also given.

Hinich, Melvin J. and **Prem P. Talwar:** "A Sample Method for Robust Regression," *Journal of the American Statistical Association* 70:349 (1975) 175-179.

Estimates of the parameters of a linear model are usually obtained by the method of ordinary least-squares (OLS), which is sensitive to large values of the additive error term. By dividing the sample into nonoverlapping subsamples and computing the trimmed means of OLS subsample regression coefficients, we obtain a simple, consistent and asymptotically normal initial estimate of the coefficients, which protects the analyst from large values of i which are often hard to detect using OLS on a model with many regressors. The technique is applied to the calculation of risk parameters in the capital asset pricing model for securities on the N. Y. Stock Exchange.

*van Aarde, I. M. R. (Faculty of Agriculture, University of Stellenbosch, Republic of South Africa): "The Effect of Linkage on the Mean Value of Inbreds Derived from a Random Mating Population," *Genetics* 78 (1974) 1245-1249.

Journal Paper No. J-7493. Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, Project 1669; partial support by National Institutes of Health Grant No. GM-13827 and National Science Foundation Grant No. 19218. SLRS 353.

An expression is derived which accounts for the effect of linkage on the mean value of diploid inbreds. The original population is taken to be in Hardy-Weinberg equilibrium. It is shown that linkage will accelerate inbreeding depression. The precise nature of the acceleration is worked out for some special cases.

*Warren, Richard D., Joan Keller White, and **Wayne A. Fuller:** "An Errors-In-Variables Analysis of Managerial Role Performance," *Journal of the American Statistical Association* 69:348 (1974) 886-893. SLRS 348.

A linear model with measurement error in the independent variables is considered. An errors-in-variables procedure is presented that provides estimators of the coefficients and their variances. If the dependent variable has multiple measures, the total variance of the dependent variable can be decomposed into measurement error, variance of true values explained by the true values of the independent variables and variance of true values not explained by the model. An application to the measurement of role performance is presented.

Warren, R. D., D. L. Rogers, and F. T. Evers: "Social System Goals in Cooperatives," *Rural Sociology* 10:1 (1975) 31-44.

Organizational goals are investigated in farmer cooperatives. An organizational goal model is constructed on the basis of Talcott Parsons' functional imperatives. The goal model includes: flexibility, satisfaction, efficiency, and productivity. Two dimensions of organizational goals are compared: general importance of the goals and the specific pressure to achieve each goal. The results show that the managers differentiated among the goals on both dimensions. The goals of efficiency and satisfaction were found to be the most important and convey the most pressure to the managers. Limited relationship was found between the dimensions of importance and pressure.

Warren, Richard D., George M. Beal, Joe M. Bohlen, and Frederick T. Evers: *Relationships of Selected Variables to Managerial Performance and Cooperative Success.* (Monograph) Sociology Report No. 114, Department of Sociology and Anthropology, Iowa State University, 1975.

Klonglan, Gerald E., Charles L. Mulford, **Richard D. Warren,** Judy M. Winkelpleck: Department of Sociology and Anthropology, Iowa State University, May, 1975. Sociology Report Series No. 122.

Creating Interorganizational Coordination: Project Report, Sociology Report No. 122A;

Creating Interorganizational Coordination: An Orientation, Sociology Report No. 122B;

Creating Interorganizational Coordination: Instructor's Guide, Sociology Report No. 122C;

Creating Interorganizational Coordination: Student's Workbook: Sociology Report No. 122D,

Wedin, Carol S., Lloyd L. Avant, and **Leroy Wolins:** "Communication of Residential Spaces by Architectural Graphics," *Architectural Psychology, Proceedings of the Lund Conference,* Richard Kuller (editor) 1973, 301-309. Journal Paper No. J-7632, Iowa Agriculture and Home Economics Experiment Station, Project No. 1882.

Four sets of four bipolar adjectives were employed to index the aesthetic appeal, physical organization, phenomenological size, and physical size of three different living rooms as represented in floor plans, isometric drawings, and photographs of the rooms. Averaged across living rooms and sets of bipolar adjectives, responses to floor plans and photographs did not differ, although responses to isometrics were less positive. All graphic forms showed one living room to be of greater aesthetic appeal, of better physical organization, and of greater phenomenological size than the other two. Surprisingly, responses to physical size were least consistent across graphic forms; depending on form of graphic representation, responses to areas varying over 147 square feet did not differ reliably.

*Zyskind, George: "Error Structures, Projections and Conditional Inverses in Linear Model Theory," 647-663. In: J. N. Strivastava (editor) *A Survey of Statistical Design and Linear Models,* North-Holland Publishing Company, 1975. SLRS 350.

*Zyskind, George: (book review) *Statistical Design and Analysis of Experiments,* Peter W. M. John, New York, The Macmillan Company, 1971. In: *Journal of the American Statistical Association* 70:349 (1975) 252-254. SLRS 349.

Theses Abstracts

Asok, Chaturvedula: "Contributions to the Theory of Unequal Probability Sampling Without Replacement," Ph.D. thesis, Iowa State University Library, August, 1974.

The inclusion probability proportional to size (I.P.P.S.) schemes that are applicable for sample size $n \geq 2$ are those of Goodman and Kish (G. K.), Hanurav, Midzuno, and Sampford. In this dissertation it has been established that the Horvitz-Thompson (H. T.) estimator corresponding to the Midzuno scheme has uniformly smaller variance than the customary with replacement estimator for arbitrary sample size, thus generalizing the result due to Rao. Using the asymptotic approach of Hartley and Rao, compact expressions for the pairwise inclusion probability P_{ij} of the Sampford's procedure correct to $O(N^{-4})$, which could be used in actual practice with much ease, have been obtained. Also it has been domonstrated that the variance to $O(N^1)$ of the H.T. estimator for Sampford's procedure is the same as that for G.K. procedure and the variance to $O(N^0)$ for Sampford's procedure is uniformly smaller than that for G.K. procedure which generalizes the result due to Rao.

The estimator proposed by Rao, Hartley, and Cochran (R.H.C.) for their procedure is inadmissible in the sense that there exists a uniformly more efficient estimator. This improved estimator is obtained by the application of the principle of sufficiency and the Rao-Blackwell theorem. Also the H.T. estimator under the R.H.C. procedure, as well as the H.T. estimator under the R.H.C. procedure with revised probabilities, wherein the revised probabilities are so chosen that the inclusion probabilities are proportional to the original size measures, are considered; and their relative performances, as measured by the variances, in relation to the R.H.C. estimator, as well as the H.T. estimators under other I.P.P.S. procedures, have been studied.

Two I.P.P.S. schemes have been presented for sample size 2, and it has been established that the H.T. estimators corresponding to these procedures are uniformly better than the H.T. estimator corresponding to the Durbin's procedure. Use of random stratification has been examined in devising I.P.P.S. procedures for sample sizes n > 2 by using the procedures for sample size 2. An alternate generalization of Durbin's procedure for samples of size greater than two has been suggested which is adoptable with much ease in practice and which yields a more efficient estimator than the Sampford's procedure. A new technique of using the ancillary information at the designing stage is proposed which is particularly useful in the case of area sampling and cluster sampling, and it has been demonstrated that the estimator proposed under this scheme is always more efficient than the Rao, Hartley, and Cochran's estimator.

Bonczkowski, Harry: "Stochastic Delay in Stop-go Network," M.S. thesis, Iowa State University Library, August, 1974.

Consider an isolated vehicle arriving at a traffic light and proceeding through a sequence of n traffic lights. Let the vehicle arrive at the first light according to some unknown probability distribution. Under certain restrictions, it is possible to determine the expected delay incurred by the vehicle as it passes through the sequence of n lights.

Restrictions assumed in this thesis are that the cycle length and the green phase are the same for each light. With the further restriction that the travel time between lights is less than the length of a cycle, and considering certain relationships between the travel time between lights and the length of the green phase, expected delay incurred by a vehicle as it proceeds through the sequence of n lights was determined.

Also consider a rectangular network of intersecting streets with traffic lights at each intersection. Under the assumption that the arrival distribution is uniform and there is an equal probability of arriving at any street, it is possible to determine the optimum length of the green phase that minimizes the expected average delay for a vehicle entering the network.

Bowerman, Bruce L.: "Nonstationary Markov Decision Processes and Related Topics in Nonstationary Markov Chains," Ph.D. thesis, Iowa State Library, August, 1974.

Initially, topics in stationary and nonstationary Markov chains related to Markov decision processes are studied. In particular, a new concept, called C-strong ergodicity, which relates to the convergence of averages of n-step transition probabilities under a certain strong norm, is defined. Conditions are then given for stationary and nonstationary Markov chains to be C-strongly ergodic.

Then, the broad applicability of C-strong ergodicity is utilized to give conditions, apparently new, under which there is a simple expression for the expected average cost associated with a C-strongly ergodic stationary or nonstationary Markov chain possessing a countably infinite stage space. If the transition probabilities or costs of a Markov decision process change with time, we call the decision process "nonstationary"; whereas, if the transition probabilities and costs are independent of time, we call the decision process "stationary." It is shown, essentially, that if the transition probabilities and costs of a nonstationary Markov decision process converge to transition probabilities and costs of a stationary Markov decision process satisfying certain conditions, then the "optimal policy" for the nonstationary Markov decision process is the "optimal policy" for the stationary Markov decision process.

Lastly, a Bayesian nonstationary Markov decision process, a nonstationary Markov decision process in which the decision maker does not know what set among a family of k sets of transition probabilities and costs governs a particular realization of the decision process, is defined. "Bayesian" decision making, i.e., updating an initial prior distribution over the k sets by Bayes' formula, leads to a process which is in a sense nonstationary, with successive transition probabilities and costs depending on the past. This notion leads to a Bayes-like policy which is in several ways optimal for our unknown parameter problem under the expected average cost criterion.

Chand, Lal: "Some Ratio-type Estimators Based on Two or More Auxiliary Variables," Ph.D. thesis, Iowa State University Library, March, 1975.

The problem of estimating $\bar{Y}_N$, the population mean of the characteristic Y under study, when the population mean of the best auxiliary variable is not known but that of some other auxiliary variable correlated with Y is either available or data on it can be easily and cheaply collected, is considered. Four classes of estimators: (i) Chain-type ratio estimators (ii) almost unbiased ratio estimators (iii) unbiased ratio-type estimators analogous to Hartley-Ross estimator and (iv) unbiased Lahiri-type ratio estimators have been proposed. These proposed estimators either do not require the knowledge of the population means of the auxiliary variables being used or, at the most, require the knowledge of the population mean of only one auxiliary variable which occurs last in the chain. Generalized estimators using λ auxiliary variables are presented.

Estimators using two auxiliary variables are studied in detail. The second order expressions for the bias and MSE of the chain-type, almost unbiased and Lahiri-type ratio estimators and exact variance for the Hartley-Ross type unbiased estimator are obtained for unistage sampling.

An extension of these estimators to multi-stage designs is presented. Estimators using λ auxiliary variables and K-stage sampling are proposed. Stratified sampling being common in practice, some separate and combined ratio-type estimators have been considered.

Comparison of estimators for unistage sampling are made with and without any model assumption. Comparisons have also been made with actual data.

Chung, Richard F.: "Geometrically Regularly Varying Monotone Functions and Iteration," Ph.D. thesis, Iowa State University Library, May, 1975.

This investigation is motivated by two open problems raised in Thomas. The first problem considered in this thesis is that of finding all possible limit laws for the stochastic games studied in Thomas and David. The second problem is the characterization of the domains of attraction of these laws. This work completes partial results in Thomas. The notion of pseudo regular variation is introduced in this connection.

Certain iteration processes of which geometric partial attraction for extreme value theory is a special case are also studied. This work substantiates the resemblance of asymptotic game value theory and asymptotic extreme value theory for geometric subsequence $F^{k^n}(x)$, k a fixed integer greater than 1, of $F^n(x)$.

Global iteration groups of functions of a real variable are also considered. In this connection, the main result, motivated by "easily iterated" maps discussed in Winger, is an extension to the not-necessarily continuous case of a theorem proved in Aczel. This extension leads to a representation theorem of a not necessarily continuous regular iteration group corresponding to the Schröder equation and to the Abel equation.

Emigh, Ted H.: "Statistical Methodology of the Nature-nurture Controversy in Human Intelligence," M.S. thesis, Iowa State University Library, August, 1974.

This thesis is an examination of the application of concepts and methods of quantitative genetics to the area of human intelligence and I Q testing.

One of the basic statistical problems in the area is the determination of the effects of various causes which may be related. This led to a development of the idea of commonality, which is a necessary ingredient in the whole study.

A critical evaluation of Fisher's theory of assortative mating with small gene effects was made, this being the main tool of leading workers in the I Q area. Also, Wright's method of path coefficients has been applied and the relation of this to the Fisher approach was examined.

The applicability of concepts of variability between and within lines to interpretations of racial differences was studied and found to be inappropriate.

The main conclusion is that resolution of the controversy on the role of heredity and environment is impossible with the existent data and existent theory.

Hidiroglu, Michael A.: "Estimation of Regression Parameters for Finite Populations," Ph.D. thesis, Iowa State University Library, November, 1974.

The limiting distribution of properly normalized sample statistics based on a simple random sample selected without replacement from a finite population is studied. Existing results on the distribution of the sample mean are extended to the properly normalized regression coefficients. It is assumed that the elements of the finite population possess bounded $2 + 2\delta$, $\delta > 0$, moments. Letting X be the vector of independent variables in the regression and Y the dependent variable, it is assumed that a Lindeberg-like condition holds for the product $X(Y - X\beta)$ where β is the population regression coefficient.

The limiting distribution of the properly normalized regression coefficients is also obtained under the assumption that the finite population is a random sample from an infinite multivariate population with finite fourth moments. The construction of a consistent estimator of the variance of the regression coefficients is discussed.

Two regression models for data subject to measurement error are considered. In one model, the data arise as a cluster sample. In the other model, the ratio of the response variance to the total variance is known. For each of these models, an estimator of the regression coefficient is constructed. The asymptotic properties of the estimator and an estimator of the variance of the estimator are given.

The small sample properties of the ordinary least squares regression estimator and an errors-in-variables regression estimator, for cluster samples selected from a finite universe, were investigated in a Monte Carlo study. For each estimator, statistics analogous to Student's t were computed using the estimated variances of the estimators. The sample distribution functions of these "t-statistics" were found to be in reasonable agreement with the Student's t distribution.

Meeker, Jeff B.: "The Use of Model Information Indicating More Than One Possible Model," Ph.D. thesis, Iowa State University Library, February, 1975.

In agricultural research, for example, it is common for studies to be repeated at different times or locations to examine possible differences in results from one repetition to another. In such cases, when information is obtained from several sources, more than one possible mathematical model may be indicated as alternative bases for statistical analysis. A Bayesian method of analyzing data when alternative models are indicated is proposed.

When several models are proposed for an experimental situation, a specification can be made in terms of the several models and associated probabilities. A multinomial random variable, called the model selection variable, is defined, along with a Dirichlet prior distribution for it, to represent the selection of one of the models. Prior distributions of the parameters for each model are also defined. General expressions for the posterior distributions are obtained in two situations according to whether the model which best fits the data is selected, say, by a model building procedure, or if no selection is made. In the first case, posterior distributions conditional on the selected model indicate that that particular model should be used for the analysis, in agreement with present practice. In the second case, marginal posterior distributions of the parameters are found.

In defining an example of the above analysis, a background effects model of the form

$$y = \tau_k + f(x,z) + e$$

is proposed where τ_k is a treatment effect, $f(x,z)$ is a general two-dimensional polynomial in x and z representing the effect of any background factors, e is an error component, and y is the measured response. The corresponding analysis for a 5 x 5 Latin square design is obtained. The analysis assuming the proposed model is compared with the usual Latin square model and marked differences in the conclusions are revealed. The data are then used to demonstrate the type of analysis based on the Bayesian methodology developed previously, yielding conclusions similar to those obtained using the background effects model.

Moritz, Thomas: "The Effects of Scaling Techniques on Cluster Analysis," M.S. thesis, Iowa State University Library, August, 1974.

Research workers using cluster analysis techniques must decide upon a measure of resemblance for use in a clustering algorithm. Two of the more commonly used measures are the correlation coefficient and Euclidean distance. This thesis discusses some properties of these measures and concludes that the correlation coefficient tends to be a measure of shape whereas Euclidean distance tends to measure size.

Several methods of scaling data are also introduced. The purpose of the proposed methods is to diminish or eliminate the influence of unusually large or small measurements on the scales chosen. A limited evaluation of the methods suggests that those involving trimming and Winsorization are preferable to the usual standardization procedure.

An example of the application of the two resemblance coefficients and the various scaling procedures is included.

O'Connell, Martin J.: "Theory and Applications of Concomitants of Order Statistics," Ph.D. thesis, Iowa State University Library, November, 1974.

In a random sample of n pairs (X_i, Y_i), $i = 1, \ldots, n$, drawn from some bivariate distribution, let $X_{r:n}$ be the rth order statistic among the X_i and let $Y_{[r:n]}$ be the Y-variate paired with $X_{r:n}$. The $Y_{[r:n]}$ which are called concomitants of order statistics, arise primarily in selection procedures based on the $X_{r:n}$.

Under the assumption that Y is linearly related to X except for an error term, a form for the probability distribution and the first two moments of $R_{r:n}$ (the rank of $Y_{[r:n]}$) is developed. In the case of bivariate normality, considerable numerical evaluation is done and, denoting the expected rank by $E(R_{r:n})$, it is shown that the exact values of $E(R_{r:n})/(n+1)$ for finite n are quite close to the asymptotic values for a wide variety of values of the correlation. A form for the c.d.f. of the $Y_{[r:n]}$ is also developed.

Concomitants are also of use in certain double sampling situations. When it is expensive to take measurements on a random variable Y in order to estimate the mean μ_y, gains may be made if an auxiliary variable X can be observed relatively cheaply. Once again assuming Y is linearly related to X except for an error term, n observations are taken on X and k (< n) are to be taken on Y. The problem considered is that of which individuals on Y are to be selected, the selection being based on the ranks of the X-variate and on the particular estimator of μ_y used. A regression estimator and several estimators requiring only a knowledge of the ranks of the X s are considered. When X has a normal distribution, extensive numerical comparisons indicate that the average of k suitably chosen Y-values is approximately as efficient as the regression estimator unless X and Y are highly correlated.

Smith, Wendell C.: "The Combination of Statistical Tests of Significance," Ph.D. thesis, Iowa State University Library, August, 1974.

In this thesis three problems related to the combination of statistical tests of significance are investigated.

First, the powers of four procedures for combining independent tests on the means of random samples from $N(\mu_i, \sigma_i^2)$ distributions, $i = 1, \ldots, k$, are compared where the σ_i^2 are assumed unknown and unequal. The test procedures considered are (1) Fisher's method, (2) the union-intersection test, (3) a test based on the likelihood ratio, and (4) a "studentized" test. Each procedure is admissible, but Fisher's test is found to have greatest power among the four methods over most of the parameter space.

Second, finite series expressions are derived for the bivariate distribution function

$$\Pr[X_1/X \leq f_1, (a_1 X_1 + a_2 X_2)/X \leq f_2]$$

where X_1, X_2 and X denote independent chi square random variables with ν_1, ν_2 and ν degrees of freedom, respectively, and a_1, a_2, f_1 and f_2 are arbitrary constants satisfying $a_1 \geq 0$, $a_2 > 0$, $f_1 > 0$ and $f_2 > 0$. Applications include the evaluation of the "family" error rate when two dependent tests involving the ratio of chi square random variables with a common denominator are considered simultaneously, and the computation of error rates when the test of a selected treatment contrast is preceded by a test for the equality of means.

Finally, the probability of "correct" model selection in multiple regression is considered for two sequential deletion model building procedures. The two procedures, referred to as the *never pool* and the *always pool* procedures, differ in the estimate of the residual error utilized in the tests that are performed at each step. A method is given for determining the sample size required by each procedure to ensure that the probability of correct selection is a specified level.

Szymczuk, Michael: "A Statistical Evaluation of a Locally Constructed Teacher Evaluation Questionnaire," M.S. thesis, Iowa State University Library, August, 1974.

The primary objective of this study is to affirm the notion that instructor differences are revealed through items relevant to instructor behavior as they appear on a teacher evaluation questionnaire. In addition, it promotes the utilization of multiple regression and defines the classroom, not a student, as the experimental unit.

For this study, the mean responses from 71 different classes in six curricula were the observational units. Each class responded to 19 items on a teacher evaluation questionnaire, as developed and distributed by the Government of the Student Body during the Fall of 1973. In order to have a proper error term for each variable investigated, the following selection criteria were necessary: 1) a course must be taught by more than one instructor and each instructor must teach more than one section, or 2) two or more instructors must teach different courses but must teach the same different courses.

For each curriculum an individual X-matrix was constructed according to the selection criteria. In essence, the X-matrix for this investigation was an aggregation of several independent X-matrices. The mean responses per class for the items of the questionnaire were regressed onto the X-matrix and several analyses resulted: an overall analysis and six single analyses. Each single analysis corresponded to a particular curriculum.

The results of this investigation generally validate the intuitive notion that items designed to distinguish among instructors do, in fact, discriminate among instructors. The fact is principally substantiated by the results of the overall analysis, which implies that there exists differences among instructor ratings which suggest instructor differences. In other words, if instructors are rated differently, given a well-defined selection criteria, then there exists differences among instructors.

Tomasiewicz, Diane M.: "A Statistical Investigation of the Optimum Limits for Determining Total Bacterial Plate Counts," M.S. Thesis, Iowa State University Library, May, 1975.

Counts for total number of bacteria are considered valid if the plate contains between 30 and 300 colonies. These limits have been intuitively determined by bacteriologists with little statistical evidence to support the choice of these boundaries. This thesis uses the mean-squared error to minimize the bias and still attain the lowest variance of the plate counts.

The results of 65 milk samples used in the study indicated that the most accurate total plate counts occur when the diluted plate has around 110 colonies per plate. When a ten-fold dilution is used for plating, these data suggest the optimum counting range is from 25-250 which is not appreciably different from the existing 30-300 standard. A considerable increase in efficiency is gained by making two-fold or five-fold dilutions (275% and 150%, respectively) when compared to the wider counting range required for the ten-fold dilution.

The statistical procedure outlined in the thesis should prove useful in evaluating the comparative value of automatic plate counting equipment currently being offered to the Dairy Industry.

Wolter, Kirk M.: "Estimators for a Nonlinear Functional Relationship," Ph.D. thesis, Iowa State University Library, August, 1974.

The nonlinear errors-in-variables model is investigated emphasizing the quadratic functional relationship. The quadratic model is based on the exact mathematical relationship

$$y_t = \beta_0 + \beta_1 x_t + \beta_2 x_t^2$$

where $Y_t = y_t + e_t$ and $X_t = x_t + u_t$ are observed for $t = 1, 2, \ldots, N$, and the random variables (e_t, u_t) denote errors of measurement.

Assuming the error variances and covariances are known, an estimator, say $'\hat{\beta}\,'$, of $\beta = (\beta_0, \beta_1, \beta_2)$ is constructed. Under minimal assumptions it is established that $\sqrt{N}\,(\hat{\beta} - \beta)$ is asymptotically normal with zero mean. A consistent estimator of the variance of $\hat{\beta}$ is given.

An iterative estimator of β is defined and investigated. Employing a preliminary estimator of β, a preliminary estimator of x_t is constructed. Then a revised estimator of β, say β^*, is constructed by linearizing the model about the preliminary estimators.

Under the assumption that the error variances are decreasing, the asymptotic properties of the ordinary least squares estimator, of $\hat{\beta}$, and of β^* are developed. Specifically, $\sqrt{N}(\beta^* - \beta)$ is shown to be asymptotically normally distributed and to have smaller asymptotic variance than the preliminary estimator $\hat{\beta}$. An estimator of the variance of β^* is given.

The nonlinear errors-in-variables model, specified by the relationship

$$y_t = g(x_t; \beta),$$

is also investigated. By analogy with the quadratic model, an iterative estimator of β is constructed and the asymptotic properties of that estimator are developed.

The estimators for the quadratic functional relationship were compared in a Monte Carlo study. To improve their small sample behavior, the estimators were modified using a constant multiple of the error variances and covariances. The sample distribution functions of the adjusted estimators were in reasonable agreement with the normal distribution. Statistics analogous to Student's t were computed using the estimated variances of the estimators. The sample distribution functions of the t's were found to be in reasonable agreement with the theoretical t distribution.

Reading Room Acquisitions

During the current year, the Statistical Laboratory has received two substantial additions to its reading room.

Roger Wilkinson of Remson, New Jersey, donated his collection of statistical journals. Included were *The American Statistician, The Annals of Mathematical Statistics, Journal of the American Statistical Association* (53 years), and a number of journals related to quality control, operations research, and management science. Dr. Wilkinson received his B.S. degree in electrical engineering from Iowa State University in 1924 and a professional degree in electrical engineering in 1950. He delivered his collection of journals to the Statistical Laboratory while attending the 50th reunion of his graduating class. Before his retirement in 1968, Dr. Wilkinson was employed by AT & T, Bell Labs, applying probability and statistics mainly to teletraffic problems. While attending Iowa State University, he was a student of Professor George W. Snedecor.

Mrs. Judy Zyskind, widow of the late George Zyskind, who was a member of the Statistical Laboratory staff from 1959-74, donated his professional library to the Statistical Laboratory and the Department of Statistics. These reference books and journals are now being processed by the library committee for inclusion in the Snedecor Hall Reading Room.

A note of special appreciation from the Statistical Laboratory staff is extended to both donors.

Statistical Laboratory Visitors

Visitors to the Statistical Laboratory included Kevin Collier and Jose Albuquerque. Mr. Collier is a consulting statistician with CSIRO, Australia. He was visiting statistical centers throughout the United States to gain an understanding of consulting programs and training available for consulting statisticians. D. F. Cox was his host while he spent a week observing the operation of the consulting arm of the laboratory.

Professor Albuquerque is an assistant professor of statistics and Chairman of the Statistical Consulting Section, Department of Statistics and Applied Mathematics, Federal University of Ceara, Brazil. His travel was sponsored by the Agency for International Development. Four statistical laboratories were scheduled on his agenda. He was concerned with the overall organization of the statistical laboratory and visited with a number of staff members during his week-long stay.

Department of Statistics

Three degrees, B.S., M.S., and Ph.D., are offered through the Department of Statistics, College of Sciences and Humanities.

The undergraduate statistics major usually combines courses which will give a basic understanding of statistical theory plus a broad or specialized area of application. This pursuit will prepare the student for graduate studies in statistics or a position as an assistant to research workers in business, government, or industry.

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 degree or undergraduate degree jointly with another department. The M.S. degree is offered with the option of thesis or nonthesis.

In addition, the Department of Statistics administers a B.S. in biometry through the cooperation of the College of Agriculture. A biometry major takes courses in statistics and mathematics and, with the guidance of an advisory committee from agriculture, selects technical agriculture courses which provide some depth of training in an agriculturally related area. This curriculum prepares the student to work with research scientists in agriculture or for graduate study in related fields.

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Donald Hotchkiss has continued his second year of work under an innovative teaching grant preparing color video tapes to be used in laboratories of beginning courses.

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Seven experimental courses were offered by the department during the year. Richard Mensing taught 305X, Engineering Statistics, to seven students mainly from Ceramic Engineering. The course emphasized engineering problems in design of experiments, analysis of variance, regression analysis, control charts, and sampling. It is hoped that several other engineering departments will also send students to this course.

Barry Simon had 12 engineering students in a one-credit laboratory, 342X. Many engineering students taking 342, Introduction to Theory of Probability and Statistics, have not had prior statistics methods courses. Problems of application in the 342X special laboratory were designed to help students develop a better understanding of statistical techniques presented in 342.

Methods of Multivariate Analysis, Statistics 407X, offered for a 3rd time, introduced 11 students to these techniques including Hotelling's T^2, multivariate analysis of variance, principal components, discriminant function analysis, canonical correlation, and cluster analysis. Primary objectives listed by Paul Hinz instructor, were to introduce research workers to multivariate analysis techniques to use in analyzing their own data and to assist students in improving their ability to critically evaluate research results reported in publications.

Ten students registered for a third offering of Survey Sampling for Social Scientists, 422X, taught by Harold Baker. Training was provided in procedures for designing samples for general and specialized household surveys with emphasis on cluster and multistage sampling. Other areas covered included: methods of estimation, use of various materials in preparing sample frames, and preparation of field materials.

Emphasis in 432X, Applied Probability Models, was on the application of probability models to engineering and science problems. Richard Mensing, instructor, offered the class for a third time winter quarter to 15 students, primarily from Civil and Industrial Engineering and Computer Science.

Statistical Methods, 500X, with Paul Hinz, instructor, attracted 34 graduate majors winter quarter. Areas of study in this course, which was introduced a year ago, centered around applications of least squares in data analysis using classificatory and functional models and emphasizing the analysis of variance. Special emphasis was placed on the use of the computer as a tool in data analysis, utilizing current computer software.

Dealing with aspects of ecological theory, Ed Pollak covered the following topics in 534X, Ecological Statistics: models of population growth; growth of populations with two competing species, parasite—host and predator-prey relationships; elementary population genetics; selection, mutation, and role of finite population size; spatial patterns in populations with one or more species; diversity; stability; information theory. Six students were enrolled.

S. Sukhatme developed 547X, Asymptotic Methods in Statistics for four graduate students. Highlights of subject matter were: a review of limit theorems covering convergence of a sequence of random variables and a sequence of distribution functions, chi-square tests for goodness of fit, asymptotic distributions of sample quantiles, distribution of moments and their functions, prop-

erties of linear rank statistics and U-statistics, optimality and efficiency of tests.

These courses have been incorporated into the 75-77 catalogue as a regular part of the curriculum.

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Four additional new graduate courses were offered for the first time this year. Oscar Kempthorne taught a 590 section on Applied Linear Models directed toward animal breeding. Twenty-five students were enrolled, and Dr. Kempthorne anticipates repeating the course in alternate years. Wayne Fuller and Jeffery Goebel were team teachers for a second course in Time Series.

Malay Ghosh presented both a one-credit seminar course in Sequential Estimation and a three-credit course in Large Sample Theory. During winter quarter his seminar, Some Topics in Sequential Estimation, concentrated on some problems of point and interval estimation which are not solvable by any fixed sample size procedure and require some sequential sampling scheme. The main objective of the course was to expose students to some of the basic problems in this area and to point out some of the as yet unsolved problems of interest. Four students enrolled in his spring quarter course which dealt with some basic problems in large sample theory. Mainly, it centered around central limit theorems for sample sums of independent and dependent random variables. Limit theorems for nonlinear statistics were also covered to some extent. Particular emphasis was placed on the Bahadur representation of quantiles. The theory of large deviations was also covered.

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1974-75 Course Offerings in Statistics

Courses for Undergraduate Students Only

100	Orientation in Statistics	R	F*	Hotchkiss
101	Principles of Statistics	5	F,W,S	Coveyou DuBose El Sabbagh Hotchkiss Ponder Umbach
104	Introduction to Statistics	5	W,S,SSI	Aleong Anderson El Sabbagh Emigh Hotchkiss Otte Simon S. Sukhatme Tu
105	Introduction to Statistics	3	F,S,	Huntsberger Meeden Mensing S. Sukhatme
127	Business Administration Statistics	5	F,W,S	El Sabbagh Hallaman Talwar Umbach

305X	Engineering Statistics	3	F	Mensing
327	Elementary Business Statistics	4	F,W,S,	El Sabbagh Fuchs Talwar
341	Introduction to Theory of Probability and Statistics	3	F,W,	Huntsberger Pollak
342	Introduction to Theory of Probability and Statistics	3	W,S,	Huntsberger Simon
342X	Statistical Theory Lab	1	W	Simon
343	Introduction to Theory of Probability and Statistics	3	S	Huntsberger
380	Statistical Applications of Digital Computers	3	F,W,S	Bubolz Gentle

Courses for Graduate Minors and Undergraduates

401	Statistical Methods for Research Workers	4	SSII,F. W,SSI	Bailey Coveyou C. P. Cox D. F. Cox Gentle Hickman Hotchkiss Meeden Mensing Strahan Warren Wolins
402	Statistical Methods for Research Workers	4	SSII,F. W,S,SSI	Bailey Bancroft Coveyou C. P. Cox D. F. Cox Han Hickman Hinz Meeden Simon Strahan Warren
403	Nonparametric Statistical Methods	4	F	Talwar
407X	Methods of Multivariate Analysis	3	F	Hinz
411	Experimental Designs for Research Workers	3	S,SSI	D. F. Cox Hinz Hotchkiss Strahan
421	Survey Designs for Research Workers	3	SSII,S	B. Sukhatme
422X	Survey Sampling for Social Scientists	4	W	Baker
431	Elementary Statistical Quality Control	3	S	Mensing
432X	Applied Probability Models	3	W	Mensing
436	Genetic Statistics for Research Workers	3	F	Bailey
446	Statistical Theory for Research Workers	3	F	Hinz
447	Statistical Theory for Research Workers	3	W,SSI	Bancroft Mensing
448	Statistical Theory for Research Workers	3	SSII,S	Hinz Huntsberger
481	Processing of Statistical Data	2	W	Gentle
482	Processing of Statistical Data	2	S	Gentle
490	Special Problems	Arr.	SSII, F,S,SSI	H. T. David Gentle Strahan

Courses Primarily for Graduate Students, Major and Minor

500X	Statistical Methods	3	W	Hinz
501	Intermediate Statistical Methods	3	F	Bancroft
505	Psychometrics	3	S	Wolins
506	Factor Analysis	3	F	Wolins
508	Econometric Statistics	3	F	Warren
511	Design of Experiments	3	S	Kempthorne
512	Design of Experiments	3	F	Kempthorne
521	Design of Surveys	3	W	B. Sukhatme
522	Design of Surveys	3	S	B. Sukhatme
531	Industrial Statistics: Process Control	3	F	H. T. David
533	Industrial Statistics: Reliability	3	S	C. P. Cox
534X	Ecological Statistics	3	S	Pollak
535	Biological Statistics	3	S	C. P. Cox
538	Econometric Statistics	3	F	Fuller
539	Operations Research	3	W	H. T. David, Mensing
540	Operations Research Methods and Economic Analysis	3	SSI	Sposito
541	Theory of Probability and Statistics	3	F	H. A. David
542	Theory of Probability and Statistics	3	W	Ghosh
543	Theory of Probability and Statistics	3	S	Han
545	Stochastic Processes	3	SSII	Isaacson
547X	Nonparametric Statistical Theory	3	F	S. Sukhatme
549	Mathematical Programming	3	S	Sposito
580	Statistical Computations on Digital Computers I	3	W	Kennedy
581	Statistical Computations on Digital Computers II	3	S	Kennedy
590	Special Problems A. Theory	Arr.	SSII,F, W,S,SSI	Han, Hinz, Isaacson, Kempthorne, Pollak
	B. Methods			Bancroft, Booth, D. F. Cox, Hickman, Kempthorne, Kennedy, Sposito
	C. Design of Experiments			Hotchkiss, Strahan
	D. Design of Surveys			C. P. Cox, Han, B. Sukhatme

Courses for Graduate Students, Major or Minor

601	Advanced Statistical Methods	3	F	C. P. Cox
611	Advanced Design of Experiments	3	W	Kempthorne
612	Advanced Design of Experiments	3	S	Kempthorne
641	General Theory of Linear Hypotheses	3	F	Ghosh
642	Probability and Distribution Theory	3	W	Isaacson
643	Theory of Estimation and Testing of Hypotheses	3	S	Meeden
646	Time Series	3	S	Fuller
647	Multivariate Analysis	3	F	Han
648	Advanced Multivariate Methods	3	SSII	Gabriel
648	Seminar on the Theory of Probability and Statistics	3	W,S,SSI	Fuller, Ghosh, Goebel, Meeden
699	Research	Arr.	SSII,F, W,S,SSI	Booth, C. P. Cox, H. A. David, H. T. David, Fuller, Han, Hinz, Hotchkiss, Isaacson, Kempthorne, Meeden, Sposito, B. Sukhatme

*Courses taught SSII 1974 through SSI 1975 are reported here.
F = Fall; W = Winter; S = Spring; SSI = Summer Session I; SSII = Summer Session II

Graduate Students

Thirty five advanced degrees in statistics were awarded this year by the Department of Statistics, 26 M.S.s and 9 Ph.D.s. Abstracts of theses written in partial fulfillment of graduation requirements appear in the publications section. A brief account of the current employment or educational plans is given for each graduate.

M.S. Recipients (Nonthesis except for asterisked names)

Zeyad Al Rawi (August, 1974, under D. F. Cox) is studying biostatistics at the School of Public Health, University of Pittsburgh, and working toward a Ph.D. degree. His long-range goal is to return to Baghdad, Iraq, and to become an employee at the Medical Research Center.

Jerry Anderson (May, 1975, under Paul N. Hinz) accepted employment with Phillips 66 Research and Development Center in Bartlesville, Oklahoma. He is serving as a consulting statistician in the Applied Mathematical Section.

*__Harry Bonczkowski__ (August, 1974, under H. T. David) remains in Ames as an employee of the Iowa Highway Commission. As a research statistician, he is responsible for all statistical work and consulting which occur within the Department of Transportation.

Kou-Ping Cheng (August, 1974, under Chien Pai Han) is employed as a statistician in San Jose, California.

Paul Du Bose (May, 1975, under Donald K. Hotchkiss) will become a research associate September 1, working under David Cox and Paul Hinz through the AES. He will be doing research and assisting in the area of multivariate statistics.

*__Ted Emigh__ (August, 1974, under Oscar Kempthorne) continues working with Drs. Kempthorne and Pollak as a research associate. He plans to pursue a Ph.D. degree in the area of population genetics.

Jino Gama (May, 1975, under C. Philip Cox) returned to Makerere University, Kampala, Uganda, as a lecturer in the Institute of Statistics and Applied Economics.

Karen Hallaman (May, 1975, under Oscar Kempthorne) will be a graduate research assistant in the fall in the Department of Industrial Engineering, Iowa State University, where she will work toward a Ph.D. degree in industrial engineering.

James Hansen (November, 1974, under Oscar Kempthorne) joined the Academy of Natural Sciences in Philadelphia as an Applied Statistician II.

Lawrence Kinyon (August, 1974, under V. A. Sposito) is employed as a research statistician assigned to the Thailand Project contracted between the Economics Department of Iowa State University and the Agency for International Development. He is developing computer software to use with agricultural surveys and economic research and training the computer staff of the Division of Agricultural Economics, University of Agriculture, Thailand.

Ricky Knight (May, 1975, under William J. Kennedy) moved to Bellaire, Texas, to accept employment as a geophysicist in the areas of computing and programming, with the Texaco Oil Company, Geophysical Center.

Gary McCormick (February, 1975, under V. A. Sposito) works as a computer systems analyst for John Deere in Moline, Illinois. His duties center around evaluation of computer system performance.

*Tom Moritz (August, 1974, under Paul Hinz) is employed at Lockheed Electronic Corporation in the Aerospace Systems Division, Houston, Texas.

Elsa Mundstock (May, 1975, under Richard W. Mensing) does not have definite employment plans at this time but will remain in Ames until her husband completes his graduate study.

Hans Otte (May, 1975, under C. Philip Cox) continues his education in the field of botany at the University of Manitoba, Canada.

K. Parvin-Jahromi (May, 1975, under C. P. Han) is a graduate student in the Department of Mathematics, University of Illinois, Chicago Circle.

Surin Phoeyglin (November, 1974, under T. A. Bancroft) returned to Thailand to conduct research in social sciences for the Thai government.

Julio Cesar Robles (May, 1975, under H. T. David) has returned to Lima, Peru, but no current information is available on his employment.

Gordon Schmittling (November, 1974, under W. J. Kennedy) was hired by the American Nurses Association to conduct survey-sampling research and to assist in the writing of their annual reports for the federal government.

Barry Simon (August, 1974, under C. Philip Cox) is a Ph.D. candidate in statistics and an instructor in the Department of Statistics.

Ann Solomon (November, 1974, under D. F. Cox) commutes from Ames to Des Moines, Iowa, and works for IBM as a systems engineer trainee.

*Michael Szymczuk (August, 1974, under Leroy Wolins) continues graduate study at Iowa State University in the Department of Education where he is a research assistant in the area of evaluation and measurement.

*Diane Tomasiewicz (May, 1975, under Donald K. Hotchkiss) is living in Ames and currently does not have employment plans.

Choosak Udomsri (August, 1974, under Dean Isaacson) returned to Bangkok as a lecturer in the Statistical Department, Faculty of Commerce and Accounting, Chulalongkorn University. He teaches applied statistics in business and introductory computer courses.

Shie-Shien Yang (November, 1974, under H. A. David) is doing research and some teaching as a graduate assistant in the Department of Statistics. He is working on a Ph.D. in the area of order statistics.

Jenn-Yung (George) Yen (May, 1975, under Glen Meeden) remains in the Department of Statistics as a Ph.D. candidate and research assistant for the AES.

Ph.D. Recipients

Chaturvedula Asok (August, 1974, under B. V. Sukhatme) is postdoctoral associate in the Survey Section of the Statistical Laboratory. His area of concentration is survey sampling research. Primarily he has been assisting with current projects in the Section.

Bruce Bowerman (August, 1974, under H. T. David and R. W. Mensing) teaches undergraduate courses in probability and statistics and graduate courses in survey sampling and probability modeling at Miami University, Oxford, Ohio. Dr. Bowerman also does statistical consulting in applied multivariate statistics in the areas of finance and marketing. His current research involves the analysis of decision processes governed by stationary and nonstationary Markov chains.

Lal Chand (February, 1975, under B. V. Sukhatme) holds the rank of statistician (associate professor) in the Statistics Department, J. N. Agricultural University, Jatalpur, M. P., India. Dr. Chand teaches statistics to graduate students in agriculture; does statistical consulting for graduate students and faculty in agriculture, veterinary science, and agricultural engineering; and conducts research in agricultural science application.

Richard Chung (May, 1975, under H. T. David and Dean L. Isaacson) returned to the National Central University in Chung-Li, China, where he will teach in the Department of Mathematics.

Michael Hidiroglu (November, 1974, under Wayne Fuller) joined Statistics Canada as a methodologist on the household surveys development staff. He participates in the design, management, implementation, and evaluation of probability sample surveys; studies the cost and efficiency of different methodologies; analyzes data for errors; and consults with clients.

Jeff Meeker (February, 1975, under C. Philip Cox) is serving the Department of Statistics, Florida State University, as a two-year post-doctoral research associate. He consults half time in the fields of biological sciences, home economics, and education for Florida State University, Florida A & M University, and other governmental agencies. He also teaches introductory statistics courses to undergraduates and consulting courses to graduates.

Martin O'Connell (November, 1974, under H. A. David) holds a post-doctoral post at the Portland Campus of Oregon State University, with primary duties as a consultant to medical research workers.

Wendell Smith (August, 1974, under Chien-Pai Han) is associated with the Department of Biostatistics, School of Public Health, University of North Carolina, Chapel Hill.

Kirk Wolter (August, 1974, under Wayne A. Fuller) is employed in Washington, D.C., by the Census Bureau as a mathematical statistician of the Research Center for Measurement Methods. His areas of concentration are errors-in-variables; total survey design, particularly as it relates to sampling vs. nonsampling errors. He also assists with the re-designing of the Current Business Surveys and with the development of new estimate methodology.

Ph.D. Candidates

Aleong, John
Asok, Chaturvedula
Aziz, Mohammad (joint
 sociology-statistics)
Biyani, Shriram
Bowerman, Bruce
Carvalho, Jose
Carter, Randy
Chand, Lal
Chung, Richard
Clark, Cynthia
Dickey, David
Doctor, Pamela
DuBose, Paul
Emigh, Ted
Hasza, David
Hidiroglu, Michael
Huang, Cheng-Chi (joint
 mathematics-statistics)
Kim, Geung Ho (joint
 industrial engineering-
 statistics)

Klemm, Rebecca
Lam, Wai-Chung
Meeker, Jeffery
Mellon, James
Midha, Chand
O'Connell, Martin
Ponder, Wendell
Richards, Winston
Sakarindr, Preecha (joint
 economics-statistics)
Simon, Barry
Smith, Wendell
Sotres, David
Stangenhaus, Gabriela
Tu, Ching-Tsao
Umbach, Dale
Villasenor, Jose
Wang, George (joint
 economics-statistics)
Wolter, Kirk
Yang, Shie-Shien
Yen, Jenn-Yung (George)

Snedecor Award

David Dickey was chosen by the graduate faculty in Statistics to receive the 1975 George W. Snedecor award. Given annually to the most outstanding Ph.D. candidate in the Department of Statistics, the award was established in 1954 to honor Professor George W. Snedecor, founder and first director of the Statistical Laboratory. A year's membership in the Institute of Mathematical Statistics and a cash prize are awarded to the winner each year.

David received his B.A. and M.S. degrees from Miami University, Oxford, Ohio, in 1967 and 1969, respectively. Before coming to Iowa State, he was an instructor in the Department of Mathematics at the College of William and Mary, Williamsburg, Virginia, for two years and was a member of the mathematics faculty at Randolph Macon College in Ashland, Virginia, for one year.

At Iowa State, Dickey served as instructor in the Department of Statistics from 1972-74 and is currently a research assistant.

M.S. Candidates

Akin, Donald
Alders, Dean
Al-Rawi, Zeyad
Anderson, Jerry
Andriano, Kim
Barron, Donald
Bernhardt, Vickie
Bonczkowski, Harry
Bondy, Eric
Chen, Jengrong
Chen, Mon-Gy
Cheng, Kou-Ping
Clarkson, Brenda
Crouse, Ken (joint
 computer-science-statistics)
Ervan, Mohamed
Fernandez, Irma
Gama, Jino
Gomez, Santiago
Gust, Cathryn
Hallaman, Karen
Hanley, Janet
Hansen, James
Ho, Chung-Man
Islam, Sheikh
Iwuora, Grace
Khuantham, Ananchai (joint
 forestry-statistics)
Kinyon, Lawrence
Kiregyera, Ben
Knight, Ricky
Lamyordmakpol, Anuchit

Leelasuwanich, Thawach (joint
 economics-statistics)
McCormick, Gary
Matsui, Tsuru
Mo, Wing-hung
Moritz, Tom
Mundstock, Elsa
Otte, Hans
Pareja, Gilda
Parvin-Jahromi, K.
Pashazadeh-Monajemi, M.B.
Perez, Margarita
Phoeyglin, Surin
Pinski, Kenneth
Robles, Julio Cesar
Schmittling, Gordon
Scholl, Mary
Sedcole, Richard
Shenk, Debra
Shu, Ven Shion
Sirisukdi, Vannapha
Solomon, Ann
Sotres, Olga
Sung, Bok Park
Szymczuk, Michael
Tai, Juen-Jing Joyce
Thomas, Lana
Tomasiewicz, Diane
Udomsri, Choosak
Viroonsri, Richard
Werner, Neil
zumBrunnen, James

Bancroft Award

Dean Keppy was named winner of the 1975 T. A. Bancroft Statistics Award. Keppy was recognized for his outstanding statistics performance among doctoral candidates who have a joint major or declared minor in Statistics.

The award honors T. A. Bancroft, professor of statistics, and former director of the Statistical Laboratory and head of the Department of Statistics from 1950-72. Dean received a year's membership in the Biometric Society.

Keppy received his B.S. degree in Mathematics from Iowa State University in 1968 and served two years in the U.S. Army. He enrolled in graduate school in the Department of Genetics where he was employed as a research assistant until 1974. During the past academic year, he was a recipient of a Graduate College dissertation research assistantship.

Undergraduates

D. V. Huntsberger and Don Hotchkiss continue as academic advisors to undergraduate statistics majors. Ten students including two joint majors received B.S. degrees during the past year.

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Statistics undergraduates were well represented this year as recipients of a variety of scholastic honors. Mary Jane Coulson, Frances Meschi, Keaven Anderson, Nancee Toft, and Jill Ann Lehman were honored as being in the top 2% of their class. Nancee Toft, biometry junior, continues her second year as an awardee of a $900 Goke Estate Advanced Curriculum Scholarship in Agricultural Science. Support provided is $200, $300, and $400 for the sophomore, junior, and senior years, respectively.

Frances Meschi and Francis Diaz each received Iowa State University Graduate College Premium for Academic Excellence (PACE) awards which grant $129 quarterly for one calendar year. Frances and Francis will begin their graduate studies in the fall as graduate assistants in the Department of Statistics. Francis Diaz was initiated into Cardinal Key (Iowa State's highest honor for junior and senior men) in May. Sin Kit Tong has also been accepted by Iowa State University to begin graduate studies in statistics in the fall.

Mary Jane Coulson was one of 550 students nationwide honored with a National Science Foundation Fellowship. This grant, which is renewable for three years, awards $3600 annually to the student and $3000 annually to the participating university. Mary Jane has selected the University of Iowa for her graduate study in statistics with an area of concentration in educational evaluation and educational measurement instruments.

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Five Iowa State statistics undergraduates are currently employed in Des Moines with the Iowa Crop and Livestock Reporting Service (USDA). Summer cooperative work-study students are Rex Bennett and Gaylen Drape. Their positions are classified as GS-4, agricultural statisticians. Martha Johnston and Nancy Vance are employed as summer interviewers. Steve Johnson has accepted a permanent position with this agency.

Francis Diaz is employed for the summer by Searle Pharmaceutical Corporation, Chicago; Keaven Anderson is a summer employee of the Atomic Energy Commission, Oakridge, Tennessee. Jill Lehman, statistics freshman, is assisting Roy Hickman in the Survey Section of the Statistical Laboratory this summer. Judy Merritt is also working for Iowa State this summer in the Administrative Data Processing Service.

Gordon Meyer has begun his work with the Mississippi Crop and Livestock Reporting Service while Gary McConnell is a new junior executive at Hach Chemical Company in Ames.

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Joe McCormick, statistics sophomore, was named outstanding sophomore in the Greek system on campus. He was a member of the central committees for Veishea and Parents Weekend.

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Mary Jane Coulson presented a senior piano recital sponsored by the Department of Music in June. She was one of four guest soloists with the University symphony orchestra this year.

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Students who received the BS degree during the year were:

Sin Kit Tong—November (joint mathematics and statistics)
Stella Yin-Ling Wong—February
Mary Jane Coulson—May
Francis Diaz—May
Steven Johnson—May
Gary McConnell—May
Frances Meschi—May
Gordon Meyer—May
Andrew Yam—May
Judith Merritt—May (joint computer science and statistics)

Beverly Upchurch (left), secretary in the undergraduate office; Dr. Donald H. Hotchkiss, undergraduate advisor; and Jill Lehman, statistics freshman, check Jill's registration papers and projected program of study.

Mu Sigma Rho

Dr. Oscar Kempthorne, Mu Sigma Rho national director, initiated a new chapter of Mu Sigma Rho, national honorary statistics fraternity, at Oklahoma State University, Stillwater, Oklahoma, on October 15.

At the fall meeting of the local chapter, Professor Dennis V. Lindley, Department of Statistics, University College, London, spoke on the topic of Bernoulli trials.

On March 18, Francis Diaz, senior statistics major, was the recipient of the Mu Sigma Rho annual award presented to a statistics student who has shown academic excellence and has contributed significantly toward the Iowa State Chapter of Mu Sigma Rho. Francis's name has been engraved on a plaque which is displayed in the main office of the Statistical Laboratory. Featured speaker at this meeting was Dr. G. E. P. Box, Ronald Aylmer Fisher Profesor of Statistics, University of Wisconsin, who discussed several aspects of his Los Angeles air pollution study. Twenty-five student members were initiated into Mu Sigma Rho during the year, and honorary membership was extended to Professors Lindley and Box.

Officers for the 1975-76 academic year are:

President: Becky Klemm
Vice President: Keaven Anderson
Secretary-Treasurer: Frances Meschi
Advisor: Don Hotchkiss

Research and development in area sampling frame construction continued in cooperation with the Statistical Reporting Service, USDA. Sampling frames stratified on the basis of degree and type of cultivation will enable the design of agricultural surveys which will yield greater precision in estimates of characteristics of interest. Frames for Illinois, Ohio, and Indiana were completed during the year. Different procedures in the formation of strata and count units are usually required for various states due to differing materials available and the degree of population density present in the region. A computer editing program designed to control strata and total state acreage and the optimum size of count units is now operational. Frame construction is planned for the states of Wisconsin and Kentucky in the immediate future.

Statistics Club

Freshmen were welcomed into the Department and into the Statistics Club at the annual fall picnic. Carol (Holly) Fuchs chose as her topic "A Year Away from Ames—Statistics, Animal Breeding, and Europe" for the second meeting of the year. Dr. Fuchs and her family spent last year in Germany.

At the winter quarter meeting, Steve Johnson and Gordon Meyer, statistics seniors, discussed their experiences as summer agricultural statistician trainees working in the USDA's Des Moines office during the summer of 1974.

Club members heard Dave Drury, Associate Actuary for Bankers Life, explain opportunities in actuarial science during the January meeting.

Martha Johnson and Rich Zimmerman were co-chairmen of the Veishea Open House for the Department of Statistics. Results of a recent residence hall survey special project conducted by Keaven Anderson were displayed on posters. A second display featured the results of a mail survey of Iowa State University Department of Statistics alumni prepared and processed by Mary Jane Coulson and Rex Bennett. Areas stressed in this study were beginning and current salaries of statisticians who were ISU alumni, types of positions now held, and applicability of ISU statistics courses to individual employment needs.

The Departments of Quality Control and Time Study of the John Deere plant in Ankeny were toured during the spring field trip.

Recipient of the 1975 IBM-Statistics Club scholarship was Keaven Anderson. The scholarship is to cover one year's tuition at Iowa State.

Officers for 1975-76 are:

President—Rex Bennett
Vice President—Gaylen Drape
Secretary—Jill Lehman
Treasurer—Kathy Sibbel
Advisor—Donald Hotchkiss

SEMINARS

B. V. Sukhatme, T. B. Bailey, and Dean Isaacson comprised the committee which planned weekly non-credit seminars. They were assisted by the student representative, Jerry Anderson. All faculty members and students from statistics and related disciplines were invited.

Various aspects of statistical theory, practice, and philosophy were presented by guest speakers as well as local faculty members and students. Two joint seminars were featured—one with industrial engineering and one with quantitative genetics. An additional seminar in quantitative genetics was planned by Oscar Kempthorne and Edward Pollak.

This year's program of speakers and topics follows:

Fall Quarter, 1974

September 11 — Can We Cope with the Information Explosion in Statistics? H. A. David

September 18 — Is Statistics Dead? Oscar Kempthorne

September 25 — Estimation of Regression Parameters for Finite Populations, M. A. Hidiroglou

October 2 — Asymptotic Normality of Stopping Times in Sequential Estimation, Malay Ghosh

October 9 — Teaching Statistical Methods to Statistics Graduate Students—Which, How, and Why?, David Cox, Glen Meeden, David Dickey

October 16 — Human Intelligence and Quantitative Genetics, Ted H. Emigh

October 23 — The Wanderings of a Modern Day Statistician Through Industrial Applications, Paul H. Randolph, Visiting Professor, Industrial Engineering (Joint Seminar with Industrial Engineering)

October 30 — Some Primitive Remarks on Discrete Variates, Continuous Variates, and Some Latin Square Analyses, C. P. Cox

November 6 — Why Randomize? D. V. Lindley, Department of Statistics, University College, London (Visiting Professor at the University of Iowa)

November 13 — Remembrance of Dreams Past and Other Statistical Anomalies: Studies of Intuitive Statistical Behavior, Robert Strahan

Winter Quarter, 1975

December 4 — Alternative Econometric Model Forms, Forecasting and Naive Comparisons, Gordon C. Rausser

December 11 — On Some Unbiased Multivariate Ratio-type Estimators, Lal Chand

December 18 — Statistics and Time-Sharing: Some Experiences and Problems, Richard Chamberlain, Manager, Statistical and Mathematical Services, Cyphernetics Corp., Ann Arbor, Michigan

January 8 — Importance of Genetic Linkage in Population Improvement, T. B. Bailey

January 15 — Regular Variation and Iteration, Richard Chung

January 22 — Aspects of Simultaneous Inference, John Aleong

January 29 — On Pooling Means in Multivariate Normal Distributions, T. A. Bancroft, C. P. Han

February 5 — An Introduction to Cluster Analysis, Paul Hinz

February 12 — What Plant Scientists Need from Statistics, Kenneth J. Frey, Department of Agronomy

February 19 — Distributions of Times Spent in Various States in Some Absorbing Processes Arising in Genetics, Edward Pollak

An informal coffee hour for faculty, students, and guests was instituted this year to precede each seminar. Dr. T. B. Bailey (center), member of the seminar committee, converses with John Aleong (left) and Ted Emigh, graduate students.

Spring Quarter, 1975

March 12 — What's New in Linear Models?, David Harville, Mathematical Statistician, Aerospace Research Laboratories, Wright-Patterson AFB, Ohio

March 14 — Data Reduction in the Presence of Multicollinearity, Thomas Fomby, Ph.D. Candidate, Department of Economics, University of Missouri, Columbia

March 19 — Intervention Analysis, George E. P. Box, University of Wisconsin, Madison

March 27 — Autoregressive Integrated Moving Average Models Containing Deterministic Functions of Time, Bovas Abraham, Ph.D. Candidate, Department of Statistics, University of Wisconsin, Madison

March 31 — Admissible Estimators in a Linear Model Context, Justis Seely, Department of Statistics, Oregon State University

April 9 — Ruth Ann Killion, Ph.D. Candidate, Florida State University

April 14 — Sequential Analysis and 2 x 2 Contingency Tables, William Q. Meeker, Jr., Ph.D. Candidate, Union College, Schenectady, New York

April 23 — Bayes Estimation of the Mean and Other Functions in the Exponential Family, Glen Meeden

April 30 — Comparison Methods for Branching Processes, Peter E. Ney, University of Wisconsin, Madison (Joint Seminar with Quantitative Genetics)

May 7 — Regression Under L_1, V. A. Sposito

May 14 — The Use and Abuse of Analysis of Covariance (ANOCO) in Social Science Research, Leroy Wolins

Summer Quarter, 1975

June 13 — Some Optimal Designs for Non-optimal Situations, Agnes Herzberg, Imperial College, London University

Quantitative Genetics Seminar

November 12 — Conditions for the Existence of Clines, Thomas Nagylaki, Mathematics Research Center, The University of Wisconsin