IUPUI Department of Mathematical Sciences

July 2007

GRADUATE PROGRAM IN APPLIED STATISTICS

Statistics is the science of collecting, organizing, and interpreting numerical facts, which are called data. Statistical methods and procedures enable decision-making in scientific, medical, industrial and economic contexts, while statistical theory provides the mathematical basis for such procedures. While modern computers greatly facilitate applications of statistical techniques, they do not ensure that these methods will be applied correctly. The increasing use of statistical methods in many real life applications dictates a growing need for well-trained applied statisticians who thoroughly understand the procedures with which they work.

The Program

The Department of Mathematical Sciences at IUPUI offers a graduate program leading to the Purdue University Master of Science (M.S.) degree in Mathematics with a specialization in Applied Statistics. This program is designed to increase the number of professionals with the broad training in statistical methodology that is suitable for applications in industry, medicine, business and government. A typical student in this program will be exposed to a broad base of practical techniques and applications from a wide variety of fields. At the same time the student's background in theory is developed so that the learning process will continue in any professional environment pursued after graduation.

The primary goal of the master's degree program is to provide a basis for the skilled and competent application of modern statistical methods. In addition to the basic theoretical foundations, areas of methodology include regression analysis, design of experiments, multivariate analysis, quality control, survival analysis, time series, sample surveys, categorical and nonparametric methodology. All applied courses use and emphasize the importance of modern statistical computing software. Most courses are offered in the late afternoon or evening to accommodate students who are engaged in professional development while maintaining full-time careers.

Admission to the Program

Any applicant who has a bachelor's degree from an accredited institution and shows promise of successfully completing the degree requirements will be considered for admission. The minimal mathematics background is an undergraduate course sequence in univariate and multivariate calculus (equivalent to MATH 163, 164 and 261 at IUPUI), plus a linear algebra course equivalent to MATH 351 or MATH 511. Applicants who lack only the algebra course may be admitted conditionally and then must complete such a course as soon as practicable. Application materials are available on the departmental website: www.math.iupui.edu. Students not seeking an M.S. degree, but desiring to take graduate courses in statistics for personal development, may also take, upon approval of the graduate advisor, courses in this program under continuing non-degree graduate student classification.

Requirements for the Degree

The degree requires at least 30 credit hours of coursework. All course grades must be A or B with the possible exception of at most two grades of C. The coursework must include the 15 credit-hour core curriculum (STAT 512, 514, 519, 524 and 528). Further credits must conform to one of the two options below. Finally, each student must pass a written and an oral comprehensive examination.

Option I- No Thesis. At least 9 credit hours must be taken in Statistics beyond the core curriculum. The remaining courses may be taken in Mathematics or in areas related to Statistics, subject to the approval of the academic advisor.

Option II- Thesis. A 6-credit written thesis must be submitted for an oral defense. The thesis topic must be approved by the student's advisor. Also at least 6 credit hours must be taken in Statistics beyond the core curriculum. The remaining courses may be taken in Mathematics or in areas related to Statistics, subject to the approval of the academic advisor.

For further information on any aspects of the Applied Statistics Program, please contact Professor Jyoti Sarkar at 317-274-8112 or jsarkar@math.iupui.edu.

Statistics Faculty

Benzion Boukai, *Ph.D., 1988, State University of New York Binghamton; Professor & Chair*; Statistical inference, change-point problems, sequential analysis.

Samiran Ghosh, *Ph.D., 2006, University of Connecticut; Asst. Professor;* Biostatistics, bioinformatics.

Fang Li, *Ph.D., 2004, Michigan State University*; *Assistant Professor*; Linear and nonlinear models.

Jyotirmoy Sarkar, *Ph.D., 1990, University of Michigan; Associate Professor*; Sequential design and estimation, reliability and availability of maintained systems, applied probability and enumeration, and location theory in economics.

Robert Kleyle, *Ph.D., 1968, Harvard University; Professor Emeritus*; Applications of methods of stochastic modeling and fuzzy set theory to expert systems, allocation problems, and business related applications.

For students with disabilities who need assistance reading the information in this brochure, special arrangements can be made to accommodate most needs by contacting the Mathematics Department Office (LD 270 or 274-6918).

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Core Courses

STAT 512 Applied Regression Analysis (3 cr.) P: STAT 511. Inference in simple and multiple linear regression, estimation of model parameters, testing and prediction. Residual analysis, diagnostics and remedial measures, multicollinearity, model building, stepwise and other model selection methods. Weighted least squares. Models with qualitative independent variables. One-way analysis of variance. Extensive use of statistical computing package.

STAT 514 Design of Experiments (3 cr.) P: STAT 512. Fundamentals, completely randomized design, randomized complete blocks. Latin squares, multi- classification, factorial, nested factorial, incomplete blocks, fractional replications, confounding, general mixed factorial, split-plot and optimum design. Use of existing statistical computing package.

STAT 519 Probability Theory (3 cr.) P: MATH 261 or equivalent. Sample spaces and axioms of probability, conditional probability, independence, random variables, distribution functions, moment generating and characteristics functions, special discrete and continuous distributions -- univariate and multivariate cases, normal multivariate distributions, distribution of functions of random variables, modes of convergence and limit theorems including laws of large numbers and central limit theorem.

STAT 524 Applied Multivariate Analysis (3 cr.) P: MATH 511 and STAT 528, or equivalent or consent of instructor. Review of linear algebra and matrix theory. Extension of univariate tests in normal populations to the multivariate case, equality of covariance matrices, multivariate analysis of variance, discriminate analysis and misclassification errors, canonical correlation, principal components, factor analysis. Strong emphasis will be placed on use of existing computer programs.

STAT 528 Mathematical Statistics (3 cr.) P: STAT 519 or equivalent. Sufficiency and completeness, the exponential family of distributions, theory of point estimation, Cramer-Rao inequality, Rao-Blackwell Theorem, maximum likelihood estimation, asymptotic distributions of ML estimators, hypothesis testing, Neyman-Pearson Lemma, UMP tests, generalized likelihood ratio test, asymptotic distribution of the GLR test, sequential probability ratio test.

Elective Courses

STAT 513 Statistical Quality Control (3 cr.) P: 511. Control charts and acceptance sampling, standard acceptance plans, continuous sampling plans, sequential analysis, statistics of combinations, and some nonparametric methods. Use of existing statistical computing packages.

STAT 515 Statistical Consulting Problems (1-3 cr.) P: Consent of advisor. Consultation on real-world problems involving statistical analysis under the guidance of a faculty member. A detailed written report and an oral presentation are required.

STAT 520 Time Series and Applications (3 cr.) P: 519. A first course in stationary time series with applications in engineering, economics, and physical sciences. Stationarity, autocovariance function and spectrum; integral representation of a stationary time series and interpretation; linear filtering; transfer function models; estimation of spectrum; multivariate time series. Use of existing statistical computing packages.

STAT 521 Statistical Computing (3 cr.) C: STAT 512 or equivalent. A broad range of topics involving the use of computers in statistical methods. Collection and organization of data for statistical analysis; transferring data between statistical applications and computing platforms; techniques in exploratory data analysis; comparison of statistical packages.

STAT 522 Sampling and Survey Techniques (3 cr.) P: 512 or equivalent. Survey designs; simple random, stratified, and systematic samples; systems of sampling; methods of estimation; ratio and regression estimates; costs.

STAT 523 Categorical Data Analysis (3 cr.) P: 528 or equivalent, or consent of instructor. Models generating binary and categorical response data, two-way classification tables, measures of association and agreement, goodness-of-fit tests, testing independence, large sample properties. General linear models, logistic regression, probit and extreme value models. Loglinear models in two and higher dimensions; maximum likelihood estimation, testing goodness-of-fit, partitioning chi-square, models for ordinal data. Model building, selection, and diagnostics. Other related topics as time permits.

STAT 529 Bayesian Statistics and Applied Decision Theory (3 cr.) P: A course in statistics. C: 528 or equivalent. Foundation of statistical analysis, Bayesian and decision theoretic formulation of problems; construction of utility functions and quantifications of prior information; methods of Bayesian decision and inference, with applications; empirical Bayes; combination of evidence; game theory and minimax rules; Bayesian design and sequential analysis.

STAT 532 Elements of Stochastic Processes (3 cr.) P: 519 or equivalent. A basic course in stochastic models including discrete and continuous time processes, Markov chains, and Brownian motion. Introduction to topics such as Gaussian processes, queues and renewal processes, and Poisson processes. Application to economic models, epidemic models, and reliability problems.

STAT 533 Nonparametric Statistics (3 cr.) P: 519 or equivalent. Binomial test for dichotomous data, confidence intervals for proportions, order statistics, one-sample signed Wilcoxon rank test, two-sample Wilcoxon test, two-sample rank tests for dispersion, Kruskal-Wallis test for one-way layout. Runs test and Kendall test for independence, one- and two-sample Kolmogorov-Smirnov tests, nonparametric regression.

STAT 536 Introduction to Survival Analysis (3 cr.) P: STAT 517 or equivalent. Deals with the modern statistical methods for analyzing time-to-event data. Provides coverage of survivorship functions and censoring patterns; parametric models and likelihood methods, special life-time distributions; nonparametric inference, life-tables, estimation of cumulative hazard functions, the Kaplan-Meier estimator; one and two-sample nonparametric tests for censored data; semiparametric proportional hazards regression (Cox Regression), parameters' estimation, stratification, model fitting strategies and model interpretations.

STAT 598 Topics in Statistical Methods (1-3 cr.) P: Consent of instructor. Directed study and reports for students who wish to undertake individual reading and study on approved topics.

STAT 698 Research M.S. Thesis (6 cr.) P: Consent of advisor. M.S. thesis in applied statistics.

ECON 574 Applied Econometrics and Forecasting (3 cr.) An overview of techniques employed in economic model building, estimation and hypothesis testing. Topics covered include multi-equation systems estimation, limited dependent variable regression techniques, and forecasting.