STATISTICS
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101. Introductory Business Statistics. (C) Staff. Prerequisite(s): MATH 104 or equivalent; successful completion of STAT 101 is prerequisite to STAT 102.

Data summaries and descriptive statistics; introduction to a statistical computer package; Probability: distributions, expectation, variance, covariance, portfolios, central limit theorem; statistical inference of univariate data; Statistical inference for bivariate data: inference for intrinsically linear simple regression models. This course will have a business focus, but is not inappropriate for students in the college.

102. Introductory Business Statistics. (C) Shaman, Staff. Prerequisite(s): STAT 101.

Continuation of STAT 101. A thorough treatment of multiple regression, model selection, analysis of variance, linear logistic regression; introduction to time series. Business applications.

L/R 111. Introductory Statistics. (C) May be counted as a General Requirement Course in Formal Reasoning & Analysis. Class of 2009 & prior only. Staff. Prerequisite(s): High school algebra.

Basic ideas of probability and statistics. Statistical methods for the behavioral sciences, especially psychology. Topics include probability, estimation, hypothesis testing, regression.

112. Introductory Statistics. (C) May be counted as a General Requirement Course in Formal Reasoning & Analysis. Class of 2009 & prior only. Staff. Prerequisite(s): STAT 111.

Basic ideas of probability and statistics. Statistical methods for the behavioral sciences, especially psychology. Continuation of STAT 111. Topics are: regression, analysis of variance, experimental design, analysis of covariance.

430. (BSTA620, STAT510) Probability. (C) Staff. Prerequisite(s): MATH 114 or equivalent.

Discrete and continuous sample spaces and probability; random variables, distributions, independence; expectation and generating functions; Markov chains and recurrence theory.

431. Statistical Inference. (C) Staff. Prerequisite(s): STAT 430.

Graphical displays; one- and two-sample confidence intervals; one- and two-sample hypothesis tests; one- and two-way ANOVA; simple and multiple linear least-squares regression; nonlinear regression; variable selection; logistic regression; categorical data analysis; goodness-of-fit tests. A methodology course. This course does not have business applications but has significant overlap with STAT 101 and 102.

432. (BSTA621, STAT512) Mathematical Statistics. (B) Staff. Prerequisite(s): STAT 430 or 510 or equivalent.

An introductory course in the mathematical theory of statistics. Topics include estimation, confidence intervals, hypothesis testing, decision theory models for discrete data, and nonparametric statistics.

433. Stochastic Processes. (B) Foster. Prerequisite(s): STAT 430, or permission of instructor.

This course is to be a basic introduction to stochastic processes. The primary focus will be on Markov chains both in discrete time and in continuous time. By focusing attention on Markov chain, we can discuss many interesting models (from physics to economics). Topics covered include: stable distributions, birth-death processes, Poisson processes, time reversibility, random walks, Brownian motion and Black-Scholes.

434. Financial and Economic Time Series. (A) Steele. Prerequisite(s): STAT 101 - 102 or 431. Familiarity with linear algebra.

This course will introduce students to the time series methods and practices which are most relevant to the analysis of financial and economic data. After an introduction to the statistical programming language S-Plus the course develops an autoregressive models, moving average models, and their generalizations. The course then develops models that are closely focused on particular features of financial series such as the challenges of time dependent volatility.

435. (STAT711) Forecasting Methods for Management. (B) Shaman. Prerequisite(s): STAT 102 or 112 or 431.

This course provides an introduction to the wide range of techniques available for statistical forecasting. Qualitative techniques, smoothing and decomposition of time series, regression, adaptive methods, autoregressive-moving average modeling, and ARCH and GARCH formulations will be surveyed. The emphasis will be on applications, rather than technical foundations and derivations. The techniques will be studied critically, with examination of their usefulness and limitations.

471. (STAT701) Intermediate Statistics. (B) Foster. Prerequisite(s): STAT 102 or 112 or 431.

This is a course in modern methods in statistics. It will focus on regression, time series, data mining and machine learning. The regression module will extend your knowledge of building multiple regressions. The time series module will introduce you to some ideas in finance and forecasting. The last two modules will show how these ideas can be applied to large data sets that are more frequently found in the modern age. Throughout the class databased on finance, credit card data, global warming, and the "wikipedia" will be discussed.

472. (STAT712) Decision Making under Uncertainty. (M) Stine. Prerequisite(s): STAT 102 or 112 or 431.

Fundamentals of modern decision analysis with emphasis on managerial decision making under uncertainty and risk. The basic topics of decision analysis are examined. These include payoffs and losses, utility and subjective probability, the value of information, Bayesian analysis, inference and decision making. Examples are presented to illustrate the ideas and methods. Some of these involve: choices among investment alternatives; marketing a new product; health care decisions; and costs, benefits, and sample size in surveys.

473. (STAT953) Bioinformatics. (A) Ewens. Prerequisite(s): Good background in probability and statistics at the approximate level of STAT 430 and STAT 431. The material will follow the class textbook, Ewens and Grant "Statistical Models in Bioinformatics", Springer, second edtion, 2005.

An introduction to the use of statistical methods in the increasingly important scientific areas of genomics and bioinformatics. The topics to be covered will be decided in detail after the initial class meeting, but will be taken from the following: - background probability theory of one and many random variables and of events; background statistical inference theory, classical and Bayesian; Poisson processes and Markov chain; the analysis of one and many DNA sequences, in particular shotgun sequencing, pattern analysis and motifs; substitution matrices, general random walk theory, advanced statistical inference, the theory of BLAST, hidden Markov models, microarray analysis, evolutionary models.

475. (BSTA775, STAT920) Sample Survey Design. (M) Staff. Prerequisite(s): STAT 102 or 112 or 431.

An overview of survey design and methodology. Topics include questionnaire design, effects of question wording on responses, the sampling frame, simple random sampling, stratified sampling, longitudinal designs and panel methods, data collection, nonresponse bias and missing data, and applications.

476. (MKTG476, MKTG776) Applied Probability Models in Marketing. (C) Fader. Prerequisite(s): High comfort level with basic integral calculus, and recent exposure to a formal course in probability and statistics such as STAT 430 is strongly recommended.

This course will expose students to the theoretical and empirical "building blocks" that will allow them to construct, estimate, and interpret powerful models of customer behavior. Over the years, researchers and practitioners have used these models for a wide variety of applications, such as new product sales, forecasting, analyses of media usage, and targeted marketing programs. Other disciplines have seen equally broad utilization of these techinques.

500. (BSTA550, PSYC611) Applied Regression and Analysis of Variance. (A) Rosenbaum. Prerequisite(s): STAT 102 or 112 or equivalent.

An applied graduate level course in multiple regression and analysis of variance for students who have completed an undergraduate course in basic statistical methods. Emphasis is on practical methods of data analysis and their interpretation. Covers model building, general linear hypothesis, residual analysis, leverage and influence, one-way anova, two-way anova, factorial anova. Primarily for doctoral students in the managerial, behavioral, social and health sciences.

501. (PSYC612) Introduction to Nonparametric Methods and Log-linear Models. (B) Rosenbaum. Prerequisite(s): STAT 102 or 112 or equivalent.

An applied graduate level course for students who have completed an undergraduate course in basic statistical methods. Covers two unrelated topics: loglinear and logit models for discrete data and nonparametric methods for nonnormal data. Emphasis is on practical methods of data analysis and their interpretation. Primarily for doctoral students in the managerial, behavioral, social and health sciences. May be taken before STAT 500 with permission of instructor.

502. (EDUC683) Survey Methods and Design. (B) Boruch. Prerequisite(s): STAT 510 - 511. Methods and design of field surveys in education, the social sciences, criminal justice research, and other areas. It treats methods of eliciting information through household, mail, telephone surveys, methods of assuring privacy, enhancing cooperation rates and related matters. Fundamentals of statistical sampling and sample design are covered. Much of the course is based on contemporary surveys sponsored by the National Center for Education Statistics and other federal, state, and local agencies.

510. (BSTA620, STAT430) Probability. (A) Foster. Prerequisite(s): A one year course in calculus.

Probability. Elements of matrix algebra. Discrete and continuous random variables and their distributions. Moments and moment generating functions. Joint distributions. Functions and transformations of random variables. Law of large numbers and the central limit theorem. Point estimation: sufficiency, maximum likelihood, minimum variance. Confidence intervals.

511. Statistics. (B) Staff. Prerequisite(s): STAT 510.

Tests of hypotheses. Examples of normal means and variances. Neyman-Pearson lemma. Generalized likelihood ratio tests. Ordinary least squares estimation. Inference in linear models: hypothesis tests and confidence statements. Bivariate normal distribution and correlation. Analysis of variance for one- and two-way layouts. Categorical data. Generalized least squares and autocorrelated disturbances. Lagged-variable models. Simultaneous equations models and introductory topics in econometrics.

512. (BSTA621, STAT432) Mathematical Statistics. (B) Staff. Prerequisite(s): STAT 430 or 510 or equivalent.

An introductory course in the mathematical theory of statistics. Topics include estimation, confidence intervals, hypothesis testing, decision theory models for discrete data, and nonparametric statistics.

520. Applied Econometrics I. (A) Zhao. Prerequisite(s): MATH 114 or equivalent and an undergraduate introduction to probability and statistics.

This is primarily a statistical methodology course. Regression based techniques dominate the course, including the simple linear model, multiple regression, ANOVA and ANCOVA, and related models for discrete choice data, including logistic regression. Regression techniques for Panel Data will also be presented. Real data sets will be used to demonstrate the methods and clarify the use of the techniques. At the end of the semester students are expected to be able to analyze a data set (quantitative or qualitative) wisely and conclude correctly. We will start the course with a very quick introductory review of basis statistical techniques needed such as the central limit theorem, confidence intervals and hypotheses tests. R and JMP will be used throughout the lectures.

521. Applied Econometrics II. (B) Small. Prerequisite(s): STAT 520.

This is a graduate course in econometrics for applied economics graduate students. The goal of the course is to prepare students for empirical research by investigating several important econometric methods.

530. (MATH546) Probability. (A) Pemantle. Prerequisite(s): STAT 430 or 510 or equivalent.

Measure theory and foundations of Probability theory. Zero-one Laws. Probability inequalities. Weak and strong laws of large numbers. Central limit theorems and the use of characteristic functions. Rates of convergence. Introduction to Martingales and random walk.

531. (MATH547) Stochastic Processes. (B) Pemantle. Prerequisite(s): STAT 530.

Markov chains, Markov processes, and their limit theory. Renewal theory. Martingales and optimal stopping. Stable laws and processes with independent increments. Brownian motion and the theory of weak convergence. Point processes.

541. Statistical Methods. (A) Buja. Prerequisite(s): STAT 431 or 511 or equivalent.

Multiple linear regression, logit and probit regression, analysis of variance, experimental design, log-linear models, goodness-of-fit.

542. Bayesian Methods and Computation. (B) Jensen. Prerequisite(s): STAT 430 or 510 or equivalent or permission of instructor.

Sophisticated tools for probability modeling and data analysis from the Bayesian perspective. Hierarchical models, optimization algorithms and Monte Carlo simulation techniques.

550. (BSTA622) Mathematical Statistics. (A) Small. Prerequisite(s): STAT 431 or 511 or equivalent.

Decision theory and statistical optimality criteria, sufficiency, invariance, estimation and hypothesis testing theory, large sample theory, information theory.

551. Introduction to Linear Statistical Models. (B) Brown. Prerequisite(s): STAT 550.

Properties of the multivariate and spherical normal distributions, quadratic forms, estimation and testing in the linear model with applications to analysis of variance and regression models, generalized inverses, and simultaneous inference.

552. (BSTA820) Advanced Topics in Mathematical Statistics. (A) Staff. Prerequisite(s): STAT 550 and 551.

A continuation of STAT 550.

553. Machine Learning. (B) Traskin. Prerequisite(s): STAT 510 and 512 or equivalent.

This course gives a broad overview of the machine learning and statistical pattern recognition. Some topics will be rather glanced over while others will be considered in-depth. Topics include supervised learning (generative/discriminative models, parametric/nonparametric, neural networks, support vector machines, boosting, bagging, random forests), online learning (prediction with expert advice), learning theory (VC dimension, generalization bounds, bias/variance trade-off), unsupervised learning (clustering, k-means, PCA, ICA). Most of the course concentrates on the supervised and online learning.

701. (STAT471) Advanced Statistics for Management. (B) Foster. Prerequisite(s): STAT 621 or equivalent.

This is a course in modern methods in statistics. It will focus on regression, time series, data mining and machine learning. The regression module will extend your knowledge of building multiple regressions. The time series module will introduce you to some ideas in finance and forecasting. The last two modules will show how these ideas can be applied to large data sets that are more frequently found in the modern age. Throughout the class data based on finance, credit card data, global warming, and the "wikipedia" will be discussed.

711. (STAT435) Forecasting Methods for Management. (B) Shaman. Prerequisite(s): STAT 621 or equivalent.

This course provides an introduction to the wide range of techniques available for statistical forecasting. Qualitative techniques, smoothing and decomposition of time series, regression, adaptive methods, autoregressive-moving average modeling, and ARCH and GARCH formulations will be surveyed. The emphasis will be on applications, rather than technical foundations and derivations. The techniques will be studied critically, with examination of their usefulness and limitations.

712. (STAT472) Decision Making Under Uncertainty. (M) Stine. Prerequisite(s): STAT 511 or STAT 621 or equivalent.

Fundamentals of modern decision analysis with emphasis on managerial decision making under uncertainty and risk. The basic topics of decision analysis are examined. These include payoffs and losses, utility and subjective probability, the value of information, Bayesian analysis, inference and decision making. Examples are presented to illustrate the ideas and methods. Some of these involve: choices among investment alternatives; marketing a new product; health care decisions; and costs, benefits, and sample size in surveys.

900. Advanced Probability. (M) Staff. Prerequisite(s): STAT 531 or equivalent.

The topics covered will change from year to year. Typical topics include the theory of large deviations, percolation theory, particle systems, and probabilistic learning theory.

901. (OPIM931) Stochastic Processes II. (M) Staff. Prerequisite(s): OPIM 930 or equivalent.

Martingales, optimal stopping, Wald's lemma, age-dependent branching processes, stochastic integration, Ito's lemma.

910. (BSTA852) Forecasting and Time Series Analysis. (K) Stine. Prerequisite(s): STAT 511 or 541 or equivalent.

Fourier analysis of data, stationary time series, properties of autoregressive moving average models and estimation of their parameters, spectral analysis, forecasting. Discussion of applications to problems in economics, engineering, physical science, and life science.

915. Nonparametric Inference. (M) Staff. Prerequisite(s): STAT 511 or equivalent.

Statistical inference when the functional form of the distribution is not specified. Nonparametric function estimation, density estimation, survival analysis, contingency tables, association, and efficiency.

920. (BSTA775, STAT475) Sample Survey Methods. (M) Staff. Prerequisite(s): STAT 511 or equivalent with permission of instructor.

This course will cover the design and analysis of sample surveys. The focus of attention will be on the latter, specifically, classical analyses of random sampling, stratified sampling, cluster sampling, large sample results, and other topics as time permits and students' interests dictate.

921. Observational Studies. (A) Small. Prerequisite(s): STAT 541 or 550 or permission of instructor.

This course will cover statistical methods for the design and analysis of observational studies. Topics will include the potential outcomes framework for causal inference; randomized experiments; matching, propensity score and

regression methods for controlling confounding in observational studies; tests of hidden bias; sensitivity analysis; and instrumental variables.

924. Advanced Experimental Design. (M) Staff. Prerequisite(s): STAT 552.

Factorial designs, confounding, incomplete blocks, fractional factorials, random and mixed models, response surfaces.

925. Multivariate Analysis: Methods. (M) Staff. Prerequisite(s): STAT 511 or equivalent.

Tests on mean vector, discriminant analysis, multivariate analysis of variance, canonical correlation, principal components, and factor analysis.

926. Multivariate Analysis: Theory. (M) Staff. Prerequisite(s): STAT 551 and 925.

Wishart distribution, classification theory, Bayesian inference, and the multivariate general linear model.

927. (BSTA854) Bayesian Statistical Theory and Methods. (M) Zhao. Prerequisite(s): STAT 551.

A course in Bayesian statistical theory and methods. Axiomatic developments of utility theory and subjective probability, and elements of Bayesian theory.

932. (BSTA653) Survival Models and Analysis Methods for Medical and Biological Data. (M) Zhao. Prerequisite(s): STAT 551.

Parametric models, nonparametric methods for one-and two-sample problems, proportional hazards model, inference based on ranks. Problems will be considered from clinical trials, toxicology and tumorigenicity studies, and epidemiological studies.

933. Analysis of Categorical Data. (M) Rosenbaum. Prerequisite(s): STAT 541 and 551.

Likelihood equations for log-linear models, properties of maximum likelihood estimates, exact and approximate conditional inference, computing algorithms, weighted least squares methods, and conditional independence and log-linear models. Applied topics, including interpretation of log-linear and logit model parameters, smoothing of tables, goodness-of-fit, and incomplete contingency tables.

940. Advanced Inference I. (M) Staff. Prerequisite(s): STAT 551.

The topics covered will change from year to year. Typical topics include sequential analysis, nonparametric function estimation, robustness, bootstrapping and applications decision theory, likelihood methods, and mixture models.

941. Advanced Inference II. (M) Staff. Prerequisite(s): STAT 940.

A continuation of STAT 940.

SM 950. (STAT951) Statistical Practice I. (M) Staff. Prerequisite(s): STAT 540, 541, 550, and 551.

Students will be exposed to the conceptual and practical difficulties of actual statistical practice. Each student will be assigned to work on one or more applied problems arising in the Statistical Consulting Laboratory.

SM 951. (STAT950) Statistical Practice II. (M) Staff. Prerequisite(s): STAT 540, 541, 550 and 551.

A continuation of STAT 950.

953. (STAT473) Bioinformatics. (A) Ewens. Prerequisite(s): Good background in probability and statistics at the approximate level of STAT 430 and STAT 431. The material will follow the class textbook, Ewens and Grant "Statistical Models in Bioinformatics", Springer, second edtion, 2005.

An introduction to the use of statistical methods in the increasingly important scientific areas of genomics and bioinformatics. The topics to be covered will be decided in detail after the initial class meeting, but will be taken from the following: - background probability theory of one and many random variables and of events; background statistical inference theory, classical and Bayesian; Poisson processes and Markov chain; the analysis of one and many DNA sequences, in particular shotgun sequencing, pattern analysis and motifs; substitution matrices, general random walk theory, advanced statistical inference, the theory of BLAST, hidden Markov models, microarray analysis, evolutionary models.

955. Stochastic Calculus and Financial Applications. (A) Steele. Prerequisite(s): STAT 900.

Selected topics in the theory of probability and stochastic processes.

956. Financial and Economic Time Series. (B) Steele. Prerequisite(s): A graduate course in statistics or econometrics. Familiarity with linear algebra.

This graduate course introduces students to the time series methods and practices which are most relevant to the analysis of financial and economic data. The course will address both theoretical and empirical issues. Extensive use will be made of the S-Plus Statistical Language, but no previous experience of S-Plus will be required. The course begins with a quick review of ARIMA models. Most of the course is devoted to ARCH, GARCH, threshold, switching Markov, state space, and nonlinear models.

SM 957. Seminar in Data Analysis. (M) Staff. Prerequisite(s): STAT 541, 551, 552, 925, or equivalents; permission of instructor.

Survey of methods for the analysis of large unstructured data sets: detection of outliers, Winsorizing, graphical techniques, robust estimators, multivariate problems.

SM 991. Seminar in Advanced Application of Statistics. (C) Staff.

This seminar will be taken by doctoral candidates after the completion of most of their coursework. Topics vary from year to year and are chosen from advance probability, statistical inference, robust methods, and decision theory with principal emphasis on applications.