Statistics and Actuarial Science

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Undergraduate majors: actuarial science (BS); statistics (BS)

Undergraduate minor: statistics

Graduate degrees: MS in actuarial science; MS in statistics; PhD in statistics

Faculty: https://stat.uiowa.edu/people

Website: https://stat.uiowa.edu/

Courses
• Statistics Courses [p. 1]
• Actuarial Science Courses [p. 4]
• Data Science Courses [p. 5]

Undergraduate Duplication and Regression Policy

Data science majors may not earn a major or minor in computer science or statistics, a major in computer science and engineering, or the Certificate in Social Science Analytics. Likewise, statistics majors may not earn a major in data science.

Undergraduate students should be aware of the duplication and regression policies concerning the following courses.


Credit for STAT:1010 Statistics and Society may be earned only if the course is taken before any of these: STAT:1015/DATA:1015 Introduction to Data Science, STAT:1020/PSQF:1020 Elementary Statistics and Inference, STAT:1030 Statistics for Business, and STAT:2010 Statistical Methods and Computing.


Statistics Courses

STAT:1000 First-Year Seminar 1 s.h.
Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.

STAT:1010 Statistics and Society 3 s.h.
Statistical ideas and their relevance to public policy, business, humanities, and the social, health, and physical sciences; focus on critical approach to statistical evidence. Requirements: one year of high school algebra or MATH:0100. GE: Quantitative or Formal Reasoning.

STAT:1015 Introduction to Data Science 3 s.h.
In today's world, massive amounts of data are increasingly collected and leveraged for knowledge discovery, policy assessment, and decision-making across many fields, including business, natural sciences, social sciences, and humanities. Topics covered include data collection, visualization, and data wrangling; basics of probability and statistical inference; fundamentals of data learning, including regression, classification, prediction, and cross-validation; computing, learning, and reporting in the R environment; and literate programming and reproducible research. Requirements: one year of high school algebra or MATH:0100. GE: Quantitative or Formal Reasoning. Same as DATA:1015.

STAT:1020 Elementary Statistics and Inference 3 s.h.
Graphing techniques for presenting data, descriptive statistics, correlation, regression, prediction, logic of statistical inference, elementary probability models, estimation and tests of significance. Requirements: one year of high school algebra or MATH:0100. GE: Quantitative or Formal Reasoning. Same as PSQF:1020.

STAT:1030 Statistics for Business 4 s.h.
Descriptive statistics, graphical presentation, elementary probability, estimation and testing, regression, correlation; statistical computer packages. GE: Quantitative or Formal Reasoning.

STAT:2010 Statistical Methods and Computing 3 s.h.
Methods of data description and analysis using SAS; descriptive statistics, graphical presentation, estimation, hypothesis testing, sample size, power; emphasis on learning statistical methods and concepts through hands-on experience with real data. Recommendations: undergraduate standing. GE: Quantitative or Formal Reasoning.

STAT:2020 Probability and Statistics for the Engineering and Physical Sciences 3 s.h.
Probability, random variables, important discrete and continuous distributions, joint distributions, transformations of random variables, descriptive statistics, point and interval estimation, tests of hypotheses, regression. Prerequisites: MATH:1560 or MATH:1860.

STAT:3100 Introduction to Mathematical Statistics I 3 s.h.
Descriptive statistics, probability, conditional probability, discrete and continuous univariate and multivariate distributions, sampling distributions. Prerequisites: MATH:1860 or MATH:1560. Same as IGPI:3100.

STAT:3101 Introduction to Mathematical Statistics II 3 s.h.
Point and interval estimation, testing statistical hypotheses, simple regression, nonparametric methods. Prerequisites: STAT:3100. Same as IGPI:3101.
STAT:3120 Probability and Statistics  4 s.h.
Models, discrete and continuous random variables and their distributions, estimation of parameters, testing statistical hypotheses. Prerequisites: MATH:1560 or MATH:1860. Same as DATA:3120, IGPI:3120.

STAT:3200 Applied Linear Regression  3 s.h.
Regression analysis with focus on applications; model formulation, checking, and selection; interpretation and presentation of analysis results; simple and multiple linear regression; logistic regression; ANOVA; polynomial regression; tree models; bootstrapping; hands-on data analysis with computer software. Prerequisites: STAT:2020 or STAT:2010 or STAT:3120. Same as DATA:3200, IGPI:3200, ISE:3760.

STAT:3210 Experimental Design and Analysis  3 s.h.
Single- and multifactor experiments; analysis of variance; multiple comparisons; contrasts; diagnostics; fixed, random, and mixed effects models; designs with blocking and/or nesting; two-level factorials and fractions thereof; use of statistical computing packages. Prerequisites: STAT:3200.

STAT:3510 Biostatistics  3 s.h.
Statistical concepts and methods for the biological sciences; descriptive statistics, elementary probability, sampling distributions, confidence intervals, parametric and nonparametric methods, one-way ANOVA, correlation and regression, categorical data. Requirements: MATH:0100 or MATH:1005 or ALEKS score of 30 or higher. Same as IGPI:3510.

STAT:3620 Quality Control  3 s.h.
Basic techniques of statistical quality control; application of control charts for process control variables; design of inspection plans and industrial experimentation; modern management aspects of quality assurance systems. Offered fall semesters. Prerequisites: STAT:2020 or BAIS:9100 or (STAT:3100 and STAT:3101 and STAT:3200). Same as CEE:3142, ISE:3600.

STAT:4100 Mathematical Statistics I  3 s.h.
Probability, conditional probability, random variables, distribution and density functions, joint and conditional distributions, various families of discrete and continuous distributions, mgf technique for sums, convergence in distribution, convergence in probability, central limit theorem. Prerequisites: MATH:2850 and MATH:2700. Same as IGPI:4100.

STAT:4101 Mathematical Statistics II  3 s.h.
Transformations, order statistics, point estimation, sufficient statistics, Rao-Blackwell Theorem, delta method, confidence intervals, likelihood ratio tests, applications. Prerequisites: STAT:4100. Same as IGPI:4101.

STAT:4143 Introduction to Statistical Methods  3 s.h.
Analysis, interpretation of research data; descriptive statistics; introduction to probability, sampling theory, statistical inference (binomial, normal distribution, t-distribution models); linear correlation, regression. Same as PSQF:4143.

STAT:4200 Statistical Methods and Computing  3 s.h.
Methods of data description and analysis using SAS; descriptive statistics, graphical presentation, estimation, hypothesis testing, sample size, power; emphasis on learning statistical methods and concepts through hands-on experience with real data. Recommendations: graduate standing in non-statistics or less quantitative major. Same as IGPI:4200.

STAT:4520 Bayesian Statistics  3 s.h.
Bayesian statistical analysis, with focus on applications; Bayesian and frequentist methods compared; Bayesian model specification, choice of priors, computational methods; hands-on Bayesian data analysis using appropriate software; interpretation and presentation of analysis results. Prerequisites: STAT:3200 and (STAT:3101 or STAT:4101 or STAT:3120). Same as IGPI:4522, PSQF:4520.

STAT:4540 Statistical Learning  3 s.h.
Introduction to supervised and unsupervised statistical learning, with a focus on regression, classification, and clustering; methods will be applied to real data using appropriate software; supervised learning topics include linear and nonlinear (e.g., logistic) regression, linear discriminant analysis, cross-validation, bootstrapping, model selection, and regularization methods (e.g., ridge and lasso); generalized additive and spline models, tree-based methods, random forests and boosting, and support-vector machines; unsupervised learning topics include principal components and clustering. Requirements: an introductory statistics course and a regression course. Recommendations: prior exposure to programming and/or software, such as R, SAS, and Matlab. Same as BAIS:4540, DATA:4540, IGPI:4540.

STAT:4560 Statistics for Risk Modeling I  3 s.h.
Simple linear regression, multiple linear regression, model diagnostics, linear models from a statistical learning perspective, generalized linear models, and implementations of these models on real data. Prerequisites: STAT:4101 with a minimum grade of C+ or STAT:5101 with a minimum grade of C+.

STAT:4561 Statistics for Risk Modeling II  3 s.h.
Regression-based time series models, decision trees, principal components analysis, cluster analysis, and implementations of these analytic techniques on real data. Prerequisites: STAT:4560 with a minimum grade of C+.

STAT:4580 Data Visualization and Data Technologies  3 s.h.
Introduction to common techniques for visualizing univariate and multivariate data, data summaries, and modeling results; how to create and interpret these visualizations and assess effectiveness of different visualizations based on an understanding of human perception and statistical thinking; data technologies for obtaining and preparing data for visualization and further analysis; students learn how to present results in written reports and use version control to manage their work. Requirements: an introductory statistics course and a regression course. Recommendations: prior exposure to basic use of statistical programming software (e.g., R or SAS) as obtained from a regression course strongly recommended. Same as DATA:4580, IGPI:4580.

STAT:4740 Large Data Analysis  3 s.h.
Current areas that deal with problem of big data; techniques from computer science, mathematics, statistics; high performance and parallel computing, matrix techniques, cluster analysis, visualization; variety of applications including Google PageRank, seismology, Netflix-type problems, weather forecasting; fusion of data with simulation; projects. Prerequisites: (CS:1210 with a minimum grade of C- or ENGR:2730 with a minimum grade of C-) and (MATH:3800 or MATH:3800) and (STAT:3200 or STAT:3200 or STAT:3200). Same as CS:4740, IGPI:4740, MATH:4740.

STAT:4750 Probabilistic Statistical Learning  3 s.h.
Essential machine learning and statistics ideas that are critical in analyzing modern complex and large data; supervised learning topics include linear models, deep neural networks, and nonparametric models; essential topics include nonlinear dimension reduction, clustering, and recommender systems. Prerequisites: (CS:1210 with a minimum grade of C- or ENGR:2730 with a minimum grade of C-) and (MATH:2700 or MATH:2550) and (STAT:2010 or STAT:2020 or STAT:4200) and STAT:4540. Same as DATA:4750.

STAT:5090 ALPHA Seminar  1 s.h.
Resources available to students, program requirements, tips for academic success, professional statistical organizations, library and career center resources, statistical computing, scientific document preparation, history of statistics. Requirements: graduate standing in statistics.
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites/Requirements</th>
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<tbody>
<tr>
<td>STAT:5100</td>
<td>Statistical Inference I</td>
<td>3 s.h.</td>
<td>Review of probability, distribution theory (multiple random variables, moment-generating functions, transformations, conditional distributions), sampling distributions, order statistics, convergence concepts, generating random samples. Prerequisites: MATH:2850 and STAT:3101.</td>
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<tr>
<td>STAT:5101</td>
<td>Statistical Inference II</td>
<td>3 s.h.</td>
<td>Continuation of STAT:5100; principles of data reduction, point estimation theory (MLE, Bayes, UMVU), hypothesis testing, interval estimation, decision theory, asymptotic evaluations. Prerequisites: STAT:5100.</td>
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<td>STAT:5200</td>
<td>Computing in Statistics</td>
<td>3 s.h.</td>
<td>R; database management; graphical techniques; importing graphics into word-processing documents (e.g., LaTeX); creating reports in LaTeX; SAS; simulation methods (Monte Carlo studies, bootstrap, etc.). Prerequisites: CS:1210 and STAT:3200 and (STAT:3120 or STAT:3101 or STAT:4101). Corequisites: STAT:5100 and STAT:5200 if not already completed. Same as DATA:5400, IGPI:5400.</td>
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<tr>
<td>STAT:5610</td>
<td>Regression Modeling and ANOVA in the Health Sciences</td>
<td>3 s.h.</td>
<td>Continuation of BIOS:4120; correlation, simple and multiple linear regression, confounding, interactions, model selection, single and multiple factor ANOVA (analysis of variance) models, contrasts, multiple comparisons, nested and block designs; introduction to mixed models; for non-biostatistics majors. Offered spring semesters. Prerequisites: BIOS:4120. Same as BIOS:5120, IGPI:5120.</td>
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<tr>
<td>STAT:5810</td>
<td>Research Data Management</td>
<td>3 s.h.</td>
<td>Introduction to data management techniques and problems encountered in gathering and processing data from biomedical investigations; introduction to SAS, techniques taught in SAS; designed for non-biostatistics majors. Offered fall and spring semesters. Recommendations: prior programming experience with C, C++, Python, Java, or other. Same as BIOS:5310, IGPI:5310.</td>
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<td>STAT:6200</td>
<td>Predictive Analytics</td>
<td>3 s.h.</td>
<td>Linear mixed models; generalized linear mixed models; generalized additive models; applications of these models using associated R packages. Prerequisites: STAT:4560. Corequisites: STAT:4561. Requirements: comfort working with R software environment. Same as ACTS:6200, DATA:6200.</td>
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<tr>
<td>STAT:6220</td>
<td>Statistical Consulting</td>
<td>3 s.h.</td>
<td>Realistic supervised data analysis experiences, including statistical packages, statistical graphics, writing statistical reports, dealing with complex or messy data. Offered spring semesters. Prerequisites: (STAT:3200 and STAT:3210) or (STAT:5201 and STAT:5200). Requirements: for undergraduate majors—major GPA of 3.00 or above, and grades of B or higher in STAT:3200 and STAT:3210.</td>
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<tr>
<td>STAT:6300</td>
<td>Probability and Stochastic Processes I</td>
<td>3 s.h.</td>
<td>Conditional expectations; Markov chains, including random walks and gambler's ruin; classification of states; stationary distributions; branching processes; Poisson processes; Brownian motion. Prerequisites: STAT:4100.</td>
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<tr>
<td>STAT:6301</td>
<td>Probability and Stochastic Processes II</td>
<td>3 s.h.</td>
<td>Markov chains with continuous state space, Martingales, random walks, Brownian motion and other continuous-time Markov chains, simulation methods. Prerequisites: STAT:6300.</td>
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<tr>
<td>STAT:6530</td>
<td>Environmental and Spatial Statistics</td>
<td>3 s.h.</td>
<td>Geostatistics kriging, variogram estimation, trend estimation, sampling design, extensions to river networks and the globe, lattice data analysis, analysis of spatial point patterns. Prerequisites: STAT:4101 and STAT:3200. Same as IGPI:6530.</td>
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<td>STAT:6547</td>
<td>Nonparametric Statistical Methods</td>
<td>3 s.h.</td>
<td>Selected nonparametric methods; one- and two-sample location tests and estimation methods, measures of association, analyses of variance; emphasis on relationships to classical parametric procedures. Same as PSQF:6247.</td>
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<td>STAT:6550</td>
<td>Introductory Longitudinal Data Analysis</td>
<td>3 s.h.</td>
<td>Introduction to statistical models and estimation methods for outcome variables (normal and non-normal) clustered or measured repeatedly in time or space; focus on applications and computer software methods for ANOVA based methods, hierarchical linear models, linear mixed models, correlated regression models, generalized estimating equations, and generalized linear mixed models. Offered fall semesters. Prerequisites: BIOS:5120 or STAT:3200. Same as BIOS:6310, IGPI:6310.</td>
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<tr>
<td>STAT:6560</td>
<td>Applied Time Series Analysis</td>
<td>3 s.h.</td>
<td>General stationary, nonstationary models, autocovariance functions; stationary, nonstationary autoregressive integrated moving average models; identification, estimation, forecasting in linear models; use of statistical computer packages. Offered spring semesters. Prerequisites: (STAT:5200 or STAT:3200) and STAT:3101.</td>
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<tr>
<td>STAT:6970</td>
<td>Topics in Statistics</td>
<td>3 s.h.</td>
<td>Selected advanced topics in statistics.</td>
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<tr>
<td>STAT:7100</td>
<td>Advanced Inference I</td>
<td>3 s.h.</td>
<td>Concepts of convergence, asymptotic methods including the delta method, sufficiency, asymptotic efficiency, Fisher information and information bounds for estimation, maximum likelihood estimation, the EM-algorithm, Bayes estimation, decision theory. Prerequisites: STAT:5101 and STAT:5120.</td>
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STAT:7101 Advanced Inference II
Hypothesis testing, asymptotics of the likelihood ratio test, asymptotic efficiency, statistical functionals, robustness, bootstrap and jackknife, estimation with dependent data. Prerequisites: STAT:7100.

STAT:7190 Seminar: Mathematical Statistics
Selected advanced topics in mathematical statistics.

STAT:7200 Linear Models
Linear spaces and selected topics in matrix algebra, full rank and non-full rank linear models, estimability, least squares and best linear unbiased estimation, multivariate normal distribution and distributions of quadratic forms, interval estimation, hypothesis testing, random and mixed models, best linear unbiased prediction, variance component estimation. Prerequisites: STAT:5101 and STAT:5200 and STAT:5201.

STAT:7290 Seminar: Applied Statistics
Selected advanced topics in applied statistics.

STAT:7300 Foundations of Probability I
Probability theory, with emphasis on constructing rigorous proofs; measure spaces, measurable functions, random variables and induced measures, distribution functions, Lebesque integral, product measure and independence, Borel Cantelli lemma, modes of convergence. Prerequisites: STAT:5120.

STAT:7301 Foundations of Probability II
Laws of large numbers, characteristic functions and properties, central limit theorem, Radon-Nikodym derivatives, conditional expected value and martingales. Prerequisites: STAT:7300.

STAT:7390 Seminar: Probability
Selected advanced topics in probability.

STAT:7400 Computer Intensive Statistics
Computer arithmetic, random variate generation, numerical optimization, numerical linear algebra, smoothing techniques, bootstrap methods, cross-validation, MCMC, EM and related algorithms; other topics per student/instructor interests. Prerequisites: (BIOS:5710 or STAT:5200) and STAT:3101. Requirements: proficiency in Fortran or C or C++ or Java. Same as IGPI:7400.

STAT:7500 Statistical Machine Learning
Regularization methods for sparse models, computational algorithms for large scale problems, statistical inference in high-dimensional models, reproducing kernel Hilbert space, supervised learning, nonparametric density and conditional density estimation, neural networks and deep learning, optimal transport and generative learning, dimension reduction and representation learning. Prerequisites: STAT:5100 or STAT:5200. Same as BAIS:7500.

STAT:7510 Analysis of Categorical Data
Distributions and inference for categorical data; descriptive and inferential methods for contingency tables; theory and application of generalized linear models including methods for parameter estimation and testing, model selection and assessment of model adequacy; models for binary, count, and multi-category outcomes; loglinear models for contingency tables; generalized additive models; generalized linear models for longitudinal and clustered data. Offered spring semesters of odd years. Prerequisites: (BIOS:5720 or STAT:5200) and (STAT:5101 or STAT:4101). Same as BIOS:7410.

STAT:7520 Bayesian Analysis

STAT:7560 Time Series Analysis
Stationary time series, ARIMA models, spectral representation, linear prediction inference for the spectrum, multivariate time series, state space models and processes, nonlinear time series. Prerequisites: STAT:4101 and (STAT:3200 or STAT:6560).

STAT:7570 Survival Data Analysis
Types of censoring and truncation; survival function estimation; parametric inference using exponential, Weibull, and accelerated failure time models; nonparametric tests; sample size calculation; Cox regression with stratification and time-dependent covariates; regression diagnostics; competing risks; topics may include analysis of correlated survival data and/or recurrent events; designed for biostatistics and statistics majors. Offered fall semesters of odd years. Prerequisites: BIOS:5720 and ((STAT:4101 and STAT:4101) or (STAT:5100 and STAT:5110)). Same as BIOS:7210, IGPI:7210.

STAT:7990 Reading Research
Supervised reading and research in statistics.

Actuarial Science Courses

ACTS:1000 First-Year Seminar
Small discussion class taught by a faculty member; topics chosen by instructor; may include outside activities (e.g., films, lectures, performances, readings, visits to research facilities). Requirements: first- or second-semester standing.

ACTS:1001 Introductory Seminar on Actuarial Science
Introduction to actuarial science; U.S. actuarial organizations and actuarial qualification process; program requirements and tips for academic success; career center, actuarial club, and internships; actuarial career; ethics; communication; introduction to actuarial computing. Requirements: actuarial science interest major and first-year standing.

ACTS:3080 Mathematics of Finance I
Mathematics of compound interest, annuities certain, amortization schedules, yield rates, sinking funds, and bonds. Requirements: calculus II or graduate standing.

ACTS:3110 Actuarial Exam P Preparation
Preparation for the Society of Actuaries exam P. Corequisites: STAT:3100 or STAT:4100 or STAT:5100.

ACTS:3210 Actuarial Exam FM Preparation
Preparation for the Society of Actuaries exam FM. Corequisites: ACTS:3080, if not taken as a prerequisite.

ACTS:4010 Actuarial Exam IFM Preparation

ACTS:4110 Actuarial Exam LTAM Preparation
Preparation for the Society of Actuaries exam LTAM. Corequisites: ACTS:4280, if not taken as a prerequisite.

ACTS:4130 Quantitative Methods for Actuaries

ACTS:4150 Fundamentals of Short-Term Actuarial Mathematics
Severity, frequency, aggregate loss, estimation, credibility theory, pricing, and reserving for short-term insurance coverages; option pricing, Offered spring semesters. Prerequisites: STAT:4100 with a minimum grade of C+ or STAT:5100 with a minimum grade of C+. Corequisites: STAT:4101 or STAT:5101.
DATA:4880 Data Science Practicum 2 s.h.
On- or off-campus internship or group-based consulting project that provides experience in a real-world setting; application of knowledge and techniques learned in coursework; practice in communicating results to others.

DATA:5400 Computing in Statistics 3 s.h.
R; database management; graphical techniques; importing graphics into word-processing documents (e.g., LaTeX); creating reports in LaTeX; SAS; simulation methods (Monte Carlo studies, bootstrap, etc.). Prerequisites: CS:1210 and STAT:3200 and (STAT:3120 or STAT:4101). Corequisites: STAT:5100 and STAT:5200 if not already completed. Same as IGPI:5400, STAT:5400.
DATA:5890 MS Data Science Practicum 2 s.h.
On- or off-campus internship or group-based consulting project that provides experience in a real-world setting; application of knowledge and techniques learned in coursework and practice communicating results to others.

DATA:6200 Predictive Analytics 3 s.h.
Linear mixed models; generalized linear mixed models; generalized additive models; applications of these models using associated R packages. Prerequisites: STAT:4560. Corequisites: STAT:4561. Requirements: comfort working with R software environment. Same as ACTS:6200, STAT:6200.

DATA:7350 High-Dimensional Probability for Data Science 3 s.h.
Nonasymptotic probability with a view towards applications in data science; concentration inequalities for functions of independent variables, martingale inequalities, entropy method, random matrices, matrix inequalities, suprema of random processes, and sparse recovery. Prerequisites: STAT:5101. Requirements: linear algebra course and familiarity with R or Python.