

# Statistics

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## (Mathematics, Statistics, and Computer Science)

With the growing abundance of data gathered in nearly every field, statistical methods have become invaluable for transforming data into useful information. As a subject, statistics is interdisciplinary, spanning the sciences (natural and social), the humanities, and even the arts. Examples of areas of applications include economics, biology, health, education, actuarial sciences, and law. An increasing number of majors and concentrations require or recommend a statistics course.

## Overview of the Concentration

At St. Olaf, students can combine their interests in statistics with any major and acquire a background that leads to graduate study and abundant career opportunities. To find out more about the statistics concentration, visit the Statistics program (<http://wp.stolaf.edu/statistics>).

## Intended Learning Outcomes for the Concentration (<http://wp.stolaf.edu/curriculum-committee/statistics-concentration-ilos>)

## Requirements

Concentrators are encouraged to participate in an experiential learning opportunity, such as those available with the Center for Interdisciplinary Research (<http://wp.stolaf.edu/cir>).

### Required Foundation

STAT 272	Statistical Modeling	1.00
STAT 316	Advanced Statistical Modeling <sup>1</sup>	1.00

Select a prerequisite for the required foundation of the following:<sup>2</sup>

AP Statistics		
STAT 110	Principles of Statistics	
STAT 212	Statistics for the Sciences	
STAT 214	Honors Statistics for the Sciences	
ECON 263	Statistics for Economics	

### Electives

Select at least two of the following:<sup>3</sup>

CSCI 125	Computer Science for Scientists and Mathematicians (taken Spring 2013 or later)	
ECON 385	Econometrics	
MATH 262	Probability Theory (strongly recommended for mathematics majors)	

PSYCH 230	Research Methods in Psychology	
SOAN 371	Foundations of Social Science Research: Quantitative Methods	
STAT 270	Intermediate Statistics for Social Science Research	
STAT 282	Topics in Statistics	
STAT 302	Biostatistics: Design and Analysis	
STAT 322	Statistical Theory (strongly recommended for mathematics majors)	

### Experiential Learning Component (optional, see below)

**Total Credits** **5**

- 1 Mathematics/Economics double majors may substitute ECON 385 for STAT 316 as one of the core courses.
- 2 Or permission of instructor
- 3 MATH 282 and MATH 384 may count toward the concentration when a relevant topic is being taught and the student obtains the permission of the program director.

### Experiential Learning Component (Optional)

Each concentrator is encouraged to participate in experientially based research or employment that takes statistical methods beyond the traditional classroom. This can occur on- or off-campus. Prior approval by the director of statistics program and a letter after the fact from a supervisor are required to earn credit. Excellent opportunities for experiential learning in statistics are available through academic internships (STAT 294), the mathematics practicum (MATH 390), and the Center for Interdisciplinary Research (CIR) (MSCS 389). As a CIR fellow, students can work during the academic year or summer with faculty on research from a variety of disciplines.

Note: For students considering graduate school in statistics or a closely related field, the following courses are recommended:

MATH 126	Calculus II	1.00
or MATH 128	Honors Calculus II	
MATH 220	Elementary Linear Algebra	1.00
MATH 226	Multivariable Calculus	1.00
MATH 230	Differential Equations I	1.00
MATH 242	Modern Computational Mathematics	1.00
MATH 244 & MATH 344	Real Analysis I and Real Analysis II	2.00
CSCI 251 & CSCI 252	Software Design and Implementation and Software Design and Implementation Lab (0.25)	1.25

STAT 110, STAT 212, and ECON 263 all provide an introduction to statistics, and students should not take more than one; they can all serve as a prerequisite for further courses, although ECON 263 is geared toward majors in economics. STAT 214 is also an introductory course that assumes no background in statistics, but it can also be

taken by students coming from STAT 110, ECON 263 or AP Statistics who would like a transition into the statistics concentration.

## Courses

### **STAT 110: *Principles of Statistics***

This is an introductory course for the liberal arts. Students learn study design principles and develop statistical literacy and reasoning. They learn to describe distributions, assess if known distributions fit their data, estimate population values with confidence intervals, and assess statistical significance with hypothesis tests (e.g., chi-square,  $z$ -, and  $t$ -tests, ANOVA, correlation, and regression). In addition to lectures, there is a weekly computer lab. Not recommended for students who have completed a term of calculus. STAT 110, STAT 212, and ECON 263 all provide an introduction to statistics, and students should not take more than one; they all can serve as a prerequisite for further courses. Offered each semester. Counts toward environment studies major (social science emphasis) and exercise science major.

### **STAT 212: *Statistics for the Sciences***

A first course in statistical methods for scientists, this course addresses issues for proposing/designing an experiment, as well as exploratory and inferential techniques for analyzing and modeling scientific data. Topics include probability models, exploratory graphics, descriptive techniques, statistical designs, hypothesis testing, confidence intervals, and simple/multiple regression. Offered each semester. Enrollment limited for seniors. STAT 110, STAT 212, and ECON 263 all provide an introduction to statistics and students should not take more than one; they all can serve as a prerequisite for further courses. Counts toward environmental studies major (natural science and social science emphases), exercise science major, and management studies and mathematical biology concentrations; and biomedical studies concentration (for students through class of 2016).

### **STAT 214: *Honors Statistics for the Sciences***

This course engages students with the material in STAT 212 in greater depth and breadth. Topics such as bootstrapping and multiple regression will be introduced in addition to core material from STAT 212. No previous experiences with statistics is assumed; this course provides an introduction to statistics, but it can also be taken by students coming from STAT 110, ECON 263, or AP Statistics who would like a transition into the statistics concentration. Counts toward environmental studies major (social science emphasis), exercise science major, and mathematical biology concentration.

**Prerequisites:** MATH 119 or MATH 120 or equivalent, or CSCI 125, or some previous statistics (e.g., AP Statistics or STAT 110 or ECON 263).

### **STAT 270: *Intermediate Statistics for Social Science Research***

This course focuses on the use of statistics in a social science context. Students investigate three essential questions: How can one reliably measure something? How does one design valid research? How does one analyze research results? Topics include ANOVA designs (for example, one-way and two-way with interaction), data reduction methods, and principles of measurement. Interdisciplinary groups work together on case studies throughout the term. Offered in alternate years.

**Prerequisites:** STAT 110, STAT 212, or STAT 214, or ECON 263, or equivalent preparation, or permission of the instructor.

### **STAT 272: *Statistical Modeling***

This course takes a case-study approach to the fitting and assessment of statistical models with application to real data. Specific topics include multiple regression, model diagnostics, and logistic regression. The approach focuses on problem-solving tools, interpretation, mathematical models underlying analysis methods, and written statistical reports. Offered each semester. Counts toward environmental studies major (natural science and social science emphases) and management studies, mathematical biology, and neuroscience concentrations.

**Prerequisite:** STAT 110, STAT 212, or STAT 214, or ECON 263, or equivalent preparation, or permission of instructor.

### **STAT 282: *Topics in Statistics***

Students explore special topics in statistics. Topics vary from year to year. May be repeated if topic is different. Offered periodically.

### **STAT 294: *Academic Internship***

### **STAT 298: *Independent Study***

### **STAT 302: *Biostatistics: Design and Analysis***

The course investigates issues in health-related settings using a quantitative, research-oriented perspective. Course material focuses on global and public health issues, study design, methods for analyzing health data, and communication of research findings. Design topics include controlled trials, case-control, cohort and other observational studies. Methods include survival analysis and causal inference for observational studies. Communication emphasizes writing up findings and interpreting published research. Counts toward mathematical biology concentration. Offered in alternate years.

**Prerequisite:** completion of STAT 272 or permission of the instructor.

### **STAT 316: *Advanced Statistical Modeling***

This course extends and generalizes methods introduced in STAT 272 by introducing generalized linear models (GLMs) and correlated data methods. GLMs cover logistic and Poisson regression, and more. Correlated data methods include longitudinal data analysis and multi level models. Applications are drawn from across the disciplines. Offered annually in the spring semester. Counts toward neuroscience concentration.

**Prerequisite:** STAT 272.

### **STAT 322: *Statistical Theory***

This course is an investigation of modern statistical theory along with classical mathematical statistics topics such as properties of estimators, likelihood ratio tests, and distribution theory. Additional topics include Bayesian analysis, bootstrapping, Markov Chain Monte Carlo, and other computationally intensive methods. Offered annually in the fall semester. Counts toward neuroscience concentration.

**Prerequisite:** STAT 272 and MATH 262.

### **STAT 394: *Academic Internship***

### **STAT 396: *Directed Undergraduate Research***

This course provides a comprehensive research opportunity, including an introduction to relevant background material, technical instruction, identification of a meaningful project, and data collection. The topic is determined by the faculty member in charge of the course and may relate to his/her research interests. Offered based on department decision. May be offered as a 1.00 credit course or .50 credit course.

**Prerequisite:** determined by individual instructor.

**STAT 398: Independent Research****Related Courses****CSCI 125: Computer Science for Scientists and Mathematicians**

This course focuses on handling data: visualization, finding patterns, and communicating with data. The primary tools are Python (for transforming data) and R (for visualization and classification). Students work individually and in teams to apply basic principles and explore real-world datasets with a sustainability theme. Counts toward statistics and mathematical biology concentrations. One of CSCI 121, CSCI 125, or CSCI 251 counts toward linguistic studies concentration. Offered each semester.

**Prerequisite:** calculus or consent of the instructor.

**ECON 263: Statistics for Economics**

This course emphasizes skills necessary to understand and analyze economic data. Topics include descriptive statistics, probability and random variables, sampling theory, estimation and hypothesis testing, and practical and theoretical understanding of simple and multiple regression analysis. Applications to economic and business problems use real data, realistic applications, and econometric/statistical software. Offered each semester. ECON 263 is required for economics majors who do not take both STAT 272 and ECON 385. Credit towards the economics major will not be given for ECON 263 following completion of STAT 272. Counts toward environmental studies major (social science emphasis).

**Prerequisite:** MATH 119 or MATH 120 and one of Economics 110-121, or consent of the instructor.

**ECON 385: Econometrics**

Ideal for students interested in applying statistical models to economic problems, this course emphasizes theoretical foundations, mathematical structure and applications of major econometric techniques, including ordinary least squares, generalized least squares, dummy variables, non-linear transformations, instrumental variables, simultaneous equation modeling, and time series models. Students in the class complete a sophisticated economic research project of their choice. Offered annually.

**Prerequisites:** ECON 261 and either ECON 263 or STAT 272 or permission of instructor.

**MATH 262: Probability Theory**

This course introduces the mathematics of randomness. Topics include probabilities on discrete and continuous sample spaces, conditional probability and Bayes' Theorem, random variables, expectation and variance, distributions (including binomial, Poisson, geometric, normal, exponential, and gamma) and the Central Limit Theorem. Students use computers to explore these topics. Offered each semester. Counts toward management studies concentration.

**Prerequisite:** MATH 126 or MATH 128.

**MATH 390: Mathematics Practicum**

Students work in groups on substantial problems posed by, and of current interest to, area businesses and government agencies. The student groups decide on promising approaches to their problem and carry out the necessary investigations with minimal faculty involvement. Each group reports the results of its investigations with a paper and an hour-long presentation to the sponsoring organization. Offered annually during Interim.

**Prerequisite:** Permission of instructor.

**MSCS 389: Math, Statistics, and Computer Science Research Methods (0.50)**

Students focus on writing scientific papers, preparing scientific posters, and giving presentations in the context of a specific, year-long, interdisciplinary research project. In addition, this weekly seminar series builds collaborative research skills such as working in teams, performing reviews of math, statistics, and computer science literature, consulting effectively, and communicating proficiently. Exposure to post-graduate opportunities in math, statistics, and computer science disciplines is also provided. Open to students accepted into the Center for Interdisciplinary Research.

**PSYCH 230: Research Methods in Psychology**

This course prepares the student with tools for understanding how research studies in psychology are conceptualized, designed, carried out, interpreted, and disseminated to the public. Use of library and Internet resources, ethical guidelines in the conduct of research and the skills of good scientific writing are emphasized. Students work independently and in small groups to design and conduct their own research projects. The course includes lecture and laboratory work. Offered each semester. Counts toward environmental studies major (social science emphasis), exercise science major, and statistics concentration.

**Prerequisites:** PSYCH 125, and STAT 110 or STAT 212 or STAT 214 or ECON 263.

**SOAN 371: Foundations of Social Science Research: Quantitative Methods**

Students gain the skills necessary to conduct and critically evaluate quantitative research. Students learn the underlying theoretical assumptions and orientations of quantitative research, including research design, sampling techniques, strategies for data collection, and approaches to analysis. Students gain practice in data analysis by conducting a search project and using the Statistical Package for the Social Sciences (SPSS), a standard in sociology. Open to sociology/anthropology majors only. Offered annually in the fall semester. Counts toward environmental studies major (social science emphasis) and management studies concentration.

**Prerequisite:** STAT 110 or STAT 212.

**Faculty****Director, 2015-2016****Paul J. Roback**

Professor of Mathematics, Statistics, and Computer Science statistics

**Anthony Becker**

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econometrics; forecasting; economic damages; microeconomic theory; public policy

**Jessica R.B. Bestrashniy**

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