Courses offered by the Department of Statistics are listed under the subject code STATS on the Stanford Bulletin’s ExploreCourses web site.

The department’s goals are to acquaint students with the role played in science and technology by probabilistic and statistical ideas and methods, to provide instruction in the theory and application of techniques that have been found to be commonly useful, and to train research workers in probability and statistics. There are courses for general students as well as those who plan careers in statistics in business, government, industry, and teaching.

The department has long recognized the relation of statistical theory to applications. It has fostered this by encouraging a liaison with other departments in the form of joint and courtesy faculty appointments, as well as membership in various interdisciplinary programs: Biomedical Data Science, Bio-X, Center for Computational, Evolutionary and Human Genomics, Computer Science, Economics, Education, Electrical Engineering, Environmental Earth System Science, Genetics, Mathematics, Mathematical and Computational Finance, and Medicine. The research activities of the department reflect an interest in applied and theoretical statistics and probability. There are workshops in biology/medicine and in environmental factors in health.

In addition to courses for Statistics students, the department offers a number of service courses designed for students in other departments. These tend to emphasize the application of statistical techniques rather than their theoretical development.

The department has always drawn visitors from other countries and universities, and as a result there are a wide range of seminars offered by both the visitors and the department’s own faculty.

Undergraduate Programs in Statistics

The department offers a minor in Statistics and in Data Science (https://statistics.stanford.edu/academics/undergraduate-programs). Program details can be found under the Minor section.

Undergraduates Interested in Statistics

Students wishing to build a concentration in probability and statistics are encouraged to consider declaring a major in Mathematical and Computational Science (https://mcs.stanford.edu). This interdisciplinary program is administered in the Department of Statistics and provides core training in computing, mathematics, operations research, and statistics, with opportunities for further elective work and specialization. See the "Mathematical and Computational Science" section of this bulletin.

Graduate Programs in Statistics

University requirements for the M.S. and Ph.D. degrees are discussed in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees)" section of this bulletin.

Learning Outcomes (Graduate)

The purpose of the master's program is to further develop knowledge and skills in Statistics and to prepare students for a professional career or doctoral studies. This is achieved through completion of courses, in the primary field as well as related areas, and experience with independent work and specialization.

The Ph.D. is conferred upon candidates who have demonstrated substantial scholarship and the ability to conduct independent research and analysis in Statistics. Through completion of advanced course work and rigorous skills training, the doctoral program prepares students to make original contributions to the knowledge of Statistics and to interpret and present the results of such research.

The Department of Statistics offers two minor programs for undergraduates, a minor in Data Science and a minor in Statistics. To declare either minor for a degree program, visit the Statistics website (https://statistics.stanford.edu/academic-programs/undergraduate-programs) and submit the appropriate form to the department.

Minor in Data Science

The undergraduate Data Science minor has been designed for majors in the humanities and social sciences who want to gain practical knowledge of statistical data analytic methods as it relates to their field of interest. The minor:

- provides students with the knowledge of exploratory and confirmatory data analyses of diverse data types such as text, numbers, images, graphs, trees, and binary input
- strengthens social research by teaching students how to correctly apply data analysis tools and the techniques of data visualization to convey their conclusions.

No previous programming or statistical background is assumed.

Learning Outcomes

Students are expected to:

1. be able to connect data to underlying phenomena and to think critically about conclusions drawn from data analysis.
2. be knowledgeable about programming abstractions so that they can later design their own computational inferential procedures

All courses for the minor must be taken for a letter grade, with the exception of the Data Mining requirement.

Seven courses are required, 22 units minimum. An overall 2.75 grade point average (GPA) is required for courses fulfilling the minor.

Requirements

Linear Algebra

<table>
<thead>
<tr>
<th>One of the following:</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 51 Linear Algebra, Multivariable Calculus, and Modern Applications</td>
<td>5</td>
</tr>
<tr>
<td>CME 100 Vector Calculus for Engineers</td>
<td>5</td>
</tr>
</tbody>
</table>

Programming

<table>
<thead>
<tr>
<th>CS 106A Programming Methodology</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3-5</td>
</tr>
</tbody>
</table>

Programming in R

<table>
<thead>
<tr>
<th>One of the following:</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>THINK 3 Breaking Codes, Finding Patterns</td>
<td>4</td>
</tr>
<tr>
<td>STATS 32 Introduction to R for Undergraduates</td>
<td>1</td>
</tr>
<tr>
<td>STATS 48N Riding the Data Wave</td>
<td>3</td>
</tr>
<tr>
<td>STATS 195 Introduction to R</td>
<td>1</td>
</tr>
<tr>
<td>Or other course that teaches proficiency in R programming.</td>
<td></td>
</tr>
</tbody>
</table>

Data Science

<table>
<thead>
<tr>
<th>STATS 101 Data Science 101</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>
Minor in Statistics

The undergraduate minor in Statistics is designed to complement major degree programs primarily in the social and natural sciences. Students with an undergraduate Statistics minor should find broadened possibilities for employment. The Statistics minor provides valuable preparation for professional degree studies in postgraduate academic programs.

The minor consists of a minimum of six courses with a total of at least 19 units. There are two required courses (8 units) and four qualifying or elective courses (12 or more units). All courses for the minor must be taken for a letter grade. An overall 2.75 grade point average (GPA) is required for courses fulfilling the minor.

Required Courses

Both:

- STAT 116 Theory of Probability 4
- STAT 200 Introduction to Statistical Inference 3

Qualifying Courses

At most, one of these two courses may be counted toward the six course requirement for the minor:

Choose one from the following:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 52 Integral Calculus of Several Variables</td>
<td>5</td>
</tr>
<tr>
<td>STAT 191 Introduction to Applied Statistics</td>
<td>3</td>
</tr>
</tbody>
</table>

Three Elective Courses

At least one of the elective courses should be a STATS 200-level course. The remaining two elective courses may also be 200-level courses. Alternatively, one or two elective courses may be approved courses in other departments. Special topics courses and seminars for undergraduates are offered from time to time by the department, and these may be counted toward the course requirement. Students may not count any Statistics courses below the 100 level toward the minor.

Examples of elective course sequences are:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 202 Data Mining and Analysis (may be taken CR/NC)</td>
<td>3</td>
</tr>
<tr>
<td>STAT 216 Introduction to Statistical Learning</td>
<td>3</td>
</tr>
</tbody>
</table>

Elective Course

One course fulfilling Data Science methodology from cognate field of interest. Suggested courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS 224W Machine Learning with Graphs</td>
<td>3-4</td>
</tr>
<tr>
<td>ECON 291 Social and Economic Networks</td>
<td>2-5</td>
</tr>
<tr>
<td>ENGLISH 184E Literary Text Mining</td>
<td>5</td>
</tr>
<tr>
<td>LINGUIST 275 Probability and Statistics for linguists</td>
<td>2-4</td>
</tr>
<tr>
<td>MS&amp;E 135 Networks</td>
<td>3</td>
</tr>
<tr>
<td>PHIL 166 Probability: Ten Great Ideas About Chance</td>
<td>4</td>
</tr>
<tr>
<td>POLISCI 150B Machine Learning for Social Scientists</td>
<td>5</td>
</tr>
<tr>
<td>POLISCI 450A Political Methodology I: Regression</td>
<td>5</td>
</tr>
<tr>
<td>PSYCH 109 An introduction to computation and cognition</td>
<td>4</td>
</tr>
<tr>
<td>PUBLPOL 105 Empirical Methods in Public Policy</td>
<td>4-5</td>
</tr>
<tr>
<td>SOC 126 Introduction to Social Networks</td>
<td>4</td>
</tr>
<tr>
<td>SOC 180A Foundations of Social Research</td>
<td>4</td>
</tr>
<tr>
<td>or SOC 180B Introduction to Data Analysis</td>
<td></td>
</tr>
</tbody>
</table>

Master of Science in Statistics

The University’s basic requirements for the M.S. degree are discussed in the “Graduate Degrees” (http://exploredegrees.stanford.edu/graduatedegrees) section of this bulletin. The following are specific departmental requirements.

The M.S. in Statistics and the M.S. in Statistics, Data Science track, are intended as terminal degree programs and do not lead to the Ph.D. program in Statistics. Students interested in pursuing doctoral study in Statistics should apply directly to the Ph.D. program.

Admission

Prospective applicants should consult the Graduate Admissions (https://gradadmissions.stanford.edu) and the Statistics Department admissions webpages (https://statistics.stanford.edu/admissions/graduate-
application-information-and-instructions) for complete information on admission requirements and deadlines.

Recommended preparatory courses include advanced undergraduate level courses in linear algebra, statistics/probability and proficiency in programming.

Stanford students interested in the Data Science track (subplan) in Statistics must apply as external candidates. Visit Graduate Admissions (https://gradadmissions.stanford.edu) to start an application.

**Coterminal Master's Program**

Stanford undergraduates who want to apply for the coterminal master's degree in Statistics must submit a complete application to the department by the deadline published on the department's coterminal admissions webpage. (https://statistics.stanford.edu/admissions/ms/statistics-coterm-eligibility)

Applications are accepted twice a year in autumn and winter quarters for winter and spring quarter start, respectively. The general GRE is not required of coterminal applicants.

Students pursuing the Statistics coterminal master's degree must follow the same curriculum requirements stated in the Requirements for the Master of Science in Statistics section.

**University Coterminal Requirements**

Coterminal master's degree candidates are expected to complete all master's degree requirements as described in this bulletin. University requirements for the coterminal master's degree are described in the "Coterminal Master's Program (http://exploredegrees.stanford.edu/cotermdegrees)" section. University requirements for the master's degree are described in the "Graduate Degrees (http://exploredegrees.stanford.edu/graduatedegrees/#masterstext)" section of this bulletin.

After accepting admission to this coterminal master's degree program, students may request transfer of courses from the undergraduate to the graduate career to satisfy requirements for the master's degree. Transfer of courses to the graduate career requires review and approval of both the undergraduate and graduate programs on a case by case basis.

In this master's program, courses taken during or after the first quarter of the sophomore year are eligible for consideration for transfer to the graduate career; the timing of the first quarter graduate program start, respectively. The general GRE is not required of coterminal applicants.

Course transfers are not possible after the bachelor's degree has been conferred.

The University requires that the graduate adviser be assigned in the student's first graduate quarter even though the undergraduate career may still be open. The University also requires that the Master's Degree Program Proposal be completed by the student and approved by the department by the end of the student's first graduate quarter.

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**Master of Science in Statistics**

**Curriculum and Degree Requirements**

The department requires that a student's take 45 units of work from offerings in the Department of Statistics (http://explorecourses.stanford.edu/search?view=catalog&filter-coursesstatus-Active=on&Status=on&reset=on&Catalog=1&AcademicYear=2019&q=STATS&collapse=) or from authorized courses in other departments. With the advice of the master's program advisers, each student selects his or her own set of electives.

All requirements for a master's degree, including the coterminal master's degree, must be completed within three years after the student's first term of enrollment in the master's program. Ordinarily, four or five quarters are needed to complete all requirements. Honors Cooperative students must finish within five years.

Units for a given course may not be counted to meet the requirements of more than one degree, with the exception that up to 45 units of a Stanford M.A. or M.S. degree may be applied to the residency requirement for the Ph.D., D.M.A. or Engineer degrees. See the "Residency Policy for Graduate Students (http://exploredegrees.stanford.edu/graduatedegrees/#residencytext)" section of this Bulletin for University rules.

As defined in the general graduate student requirements, students must maintain a grade point average (GPA) of 3.0 (or better) for courses used to fulfill degree requirements and classes must be taken at the 200 level or higher.

**Master's Degree Program Proposal**

The Statistics Master's Degree Program Proposal form (https://statistics.stanford.edu/academic-programs/graduate-programs/ms-program-forms) must be signed and approved by the department's student services administrator before submission to the student's program adviser. This form is due no later than the end of the first quarter of enrollment in the program.

A revised program proposal must be submitted if degree plans change.

There is no thesis requirement.


**1. Statistics Core Courses (must complete all four courses):**

<table>
<thead>
<tr>
<th>Units</th>
<th>Probability</th>
<th>( \text{STATS}\ 217 ) Stochastic Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Theory of Probability</td>
<td>( \text{STATS}\ 217 ) Introduction to Stochastic Processes</td>
</tr>
<tr>
<td>3</td>
<td>Introduction to Regression Models and Analysis of Variance</td>
<td>( \text{STATS}\ 217 ) Introduction to Stochastic Processes I</td>
</tr>
<tr>
<td></td>
<td>or ( \text{STATS}\ 305A ) or ( \text{STATS}\ 191 )</td>
<td>or ( \text{STATS}\ 217 ) Introduction to Stochastic Processes II</td>
</tr>
<tr>
<td></td>
<td>Introduction to Applied Statistics</td>
<td>or ( \text{STATS}\ 217 ) Stochastic Processes</td>
</tr>
<tr>
<td></td>
<td>or ( \text{STATS}\ 300A ) or ( \text{STATS}\ 370 )</td>
<td>or ( \text{STATS}\ 318 ) Modern Markov Chains</td>
</tr>
<tr>
<td>3</td>
<td>Introduction to Statistical Inference</td>
<td>Students with prior background may replace each course with a more advanced course from the same area, or a more advanced course offered by the department, with consent of the adviser. All must be taken for a letter grade.</td>
</tr>
<tr>
<td></td>
<td>Theory of Statistics I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A Course in Bayesian Statistics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( \text{STATS}\ 217 ) Introduction to Stochastic Processes</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>or ( \text{STATS}\ 218 ) or ( \text{STATS}\ 219 ) or ( \text{STATS}\ 318 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Introduction to Stochastic Processes I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stochastic Processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modern Markov Chains</td>
<td></td>
</tr>
</tbody>
</table>

---

**2. Additional Statistics courses:**

Five additional Statistics courses must be taken from graduate offerings in the department (at or above the 200-level), all must be taken for a letter grade (with the exception of courses offered satisfactory/no credit only); except for the following courses that may only be used to fulfill elective credit \( 2 \); \( \text{STATS}\ 260A \) Workshop in Biostatistics series, \( \text{STATS}\ 299 \)
Independent Study, STATS 298 Industrial Research for Statisticians, and STATS 390 Consulting Workshop (see list of electives below).

### Courses which may be offered by the department:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATS 202</td>
<td>Data Mining and Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STATS 203</td>
<td>Introduction to Regression Models and Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STATS 204</td>
<td>Sampling</td>
<td>3</td>
</tr>
<tr>
<td>STATS 205</td>
<td>Introduction to Nonparametric Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STATS 206</td>
<td>Applied Multivariate Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STATS 207</td>
<td>Introduction to Time Series Analysis</td>
<td>3</td>
</tr>
<tr>
<td>STATS 208</td>
<td>Bootstrap, Cross-Validation, and Sample Re-use</td>
<td>3</td>
</tr>
<tr>
<td>STATS 209</td>
<td>Statistical Methods for Group Comparisons and Causal Inference</td>
<td>3</td>
</tr>
<tr>
<td>STATS 211</td>
<td>Meta-research: Appraising Research Findings, Bias, and Meta-analysis</td>
<td>3</td>
</tr>
<tr>
<td>STATS 215</td>
<td>Statistical Models in Biology</td>
<td>3</td>
</tr>
<tr>
<td>STATS 216</td>
<td>Introduction to Statistical Learning</td>
<td>3</td>
</tr>
<tr>
<td>STATS 222</td>
<td>Statistical Methods for Longitudinal Research</td>
<td>2-3</td>
</tr>
<tr>
<td>STATS 229</td>
<td>Machine Learning</td>
<td>3-4</td>
</tr>
<tr>
<td>or CS 229</td>
<td>Machine Learning</td>
<td></td>
</tr>
<tr>
<td>STATS 231</td>
<td>Statistical Learning Theory</td>
<td>3</td>
</tr>
<tr>
<td>STATS 237</td>
<td>Investment Portfolios, Derivative Securities, and Risk Measures</td>
<td>3</td>
</tr>
<tr>
<td>STATS 240</td>
<td>Statistical Methods in Finance</td>
<td>3</td>
</tr>
<tr>
<td>STATS 241</td>
<td>Data-driven Financial Econometrics</td>
<td>3</td>
</tr>
<tr>
<td>STATS 244</td>
<td>Quantitative Trading: Algorithms, Data, and Optimization</td>
<td>2-4</td>
</tr>
<tr>
<td>STATS 245</td>
<td>Data, Models and Applications to Healthcare Analytics</td>
<td>3</td>
</tr>
<tr>
<td>STATS 250</td>
<td>Mathematical Finance</td>
<td>3</td>
</tr>
<tr>
<td>STATS 263</td>
<td>Design of Experiments</td>
<td>3</td>
</tr>
<tr>
<td>STATS 266</td>
<td>Advanced Statistical Methods for Observational Studies</td>
<td>2-3</td>
</tr>
<tr>
<td>STATS 270</td>
<td>A Course in Bayesian Statistics</td>
<td>3</td>
</tr>
<tr>
<td>or STATS 370</td>
<td>A Course in Bayesian Statistics</td>
<td></td>
</tr>
<tr>
<td>STATS 271</td>
<td>Applied Bayesian Statistics</td>
<td>3</td>
</tr>
<tr>
<td>or STATS 371</td>
<td>Applied Bayesian Statistics</td>
<td></td>
</tr>
<tr>
<td>STATS 285</td>
<td>Massive Computational Experiments, Painlessly</td>
<td>2</td>
</tr>
<tr>
<td>STATS 290</td>
<td>Computing for Data Science</td>
<td>3</td>
</tr>
<tr>
<td>STATS 300A</td>
<td>Theory of Statistics I</td>
<td>3</td>
</tr>
<tr>
<td>or STATS 300B</td>
<td>Theory of Statistics II</td>
<td></td>
</tr>
<tr>
<td>or STATS 300C</td>
<td>Theory of Statistics III</td>
<td></td>
</tr>
<tr>
<td>STATS 305A</td>
<td>Applied Statistics I</td>
<td>3</td>
</tr>
<tr>
<td>or STATS 305B</td>
<td>Applied Statistics II</td>
<td></td>
</tr>
<tr>
<td>or STATS 305C</td>
<td>Applied Statistics III</td>
<td></td>
</tr>
<tr>
<td>STATS 310A</td>
<td>Theory of Probability I</td>
<td>3</td>
</tr>
<tr>
<td>or STATS 310B</td>
<td>Theory of Probability II</td>
<td></td>
</tr>
<tr>
<td>or STATS 310C</td>
<td>Theory of Probability III</td>
<td></td>
</tr>
<tr>
<td>STATS 311</td>
<td>Information Theory and Statistics</td>
<td>3</td>
</tr>
<tr>
<td>or EE 377</td>
<td>Information Theory and Statistics</td>
<td></td>
</tr>
<tr>
<td>STATS 314A</td>
<td>Advanced Statistical Theory</td>
<td>3</td>
</tr>
<tr>
<td>STATS 314B</td>
<td>Topics in Minimax Inference of Nonparametric Functionals</td>
<td>3</td>
</tr>
<tr>
<td>STATS 315A</td>
<td>Modern Applied Statistics: Learning</td>
<td>3</td>
</tr>
<tr>
<td>STATS 315B</td>
<td>Modern Applied Statistics: Data Mining</td>
<td>3</td>
</tr>
<tr>
<td>STATS 317</td>
<td>Stochastic Processes</td>
<td>3</td>
</tr>
<tr>
<td>STATS 318</td>
<td>Modern Markov Chains</td>
<td>3</td>
</tr>
<tr>
<td>STATS 319</td>
<td>Literature of Statistics</td>
<td>1</td>
</tr>
<tr>
<td>STATS 322</td>
<td>Function Estimation in White Noise</td>
<td>3</td>
</tr>
<tr>
<td>STATS 325</td>
<td>Multivariate Analysis and Random Matrices in Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STATS 359</td>
<td>Topics in Mathematical Physics</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 273</td>
<td>Causal Inference ((NEW))</td>
<td></td>
</tr>
<tr>
<td>STATS 361</td>
<td>Causal Inference ((NEW))</td>
<td></td>
</tr>
<tr>
<td>STATS 364</td>
<td>Theory and Applications of Selective Inference ((NEW))</td>
<td></td>
</tr>
<tr>
<td>STATS 366</td>
<td>Modern Statistics for Modern Biology</td>
<td>3</td>
</tr>
<tr>
<td>or MATH 234</td>
<td>Large Deviations Theory</td>
<td>3</td>
</tr>
<tr>
<td>STATS 368A</td>
<td>Information Theory</td>
<td>3</td>
</tr>
<tr>
<td>STATS 376A</td>
<td>Topics in Information Theory and Its Applications</td>
<td>3</td>
</tr>
<tr>
<td>or EE 376B</td>
<td>Topics in Information Theory and Its Applications</td>
<td></td>
</tr>
<tr>
<td>STATS 385</td>
<td>Analyses of Deep Learning</td>
<td>1</td>
</tr>
</tbody>
</table>

### 3. Linear Algebra Mathematics Requirement:

Select one of the following:

- MATH 104  Applied Matrix Theory  3
- MATH 113  Linear Algebra and Matrix Theory  3
- MATH 115  Functions of a Real Variable  3
- MATH 171  Fundamental Concepts of Analysis  3

Substitution of more advanced courses in Mathematics, that provide similar skills, may be made with consent of the adviser. All must be taken for a letter grade, with the exception of courses offered satisfactory/no credit only.

### 4. Programming Requirement:

Select one of the following:

- CS 106A  Programming Methodology  3
- CS 106B  Programming Abstractions  3
- CS 106X  Programming Abstractions  3
- CS 107  Computer Organization and Systems  3-5
- CME 108  Introduction to Scientific Computing  3

Substitution more advanced courses in Computer Science, that provide similar skills, may be made with consent of the adviser. All must be taken for a letter grade, with the exception of courses offered satisfactory/no credit only.

### 5. Elective Courses:

Suggested elective units to complete the requirements may be chosen from the list available from the program’s webpage (https://stats.stanford.edu/academics/statistics-ms-electives). Other graduate courses (200 or above) may be authorized by the adviser if they provide skills relevant to degree requirements or deal primarily with an application of statistics or probability and do not significantly overlap (repeat) courses in the student’s program.

There is sufficient flexibility to accommodate students with interests in applications to business, computing, economics, engineering, health, operations research, and biological and social sciences.

**Students may enroll in up to 6 units of the following courses:**

- STATS 242  NeuroTech Training Seminar  1
Courses below 200 level are not acceptable with the following exceptions; however, students are strongly advised to avoid redundancy in coursework:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATS 191</td>
<td>Introduction to Applied Statistics</td>
<td>3</td>
</tr>
<tr>
<td>MATH 115</td>
<td>Functions of a Real Variable</td>
<td>3</td>
</tr>
<tr>
<td>MATH 171</td>
<td>Fundamental Concepts of Analysis</td>
<td>3</td>
</tr>
<tr>
<td>CS 106A</td>
<td>Programming Methodology</td>
<td>3-5</td>
</tr>
<tr>
<td>CS 106B</td>
<td>Programming Abstractions</td>
<td>3-5</td>
</tr>
<tr>
<td>CS 106X</td>
<td>Programming Abstractions</td>
<td>3-5</td>
</tr>
<tr>
<td>CS 140</td>
<td>Operating Systems and Systems Programming</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 142</td>
<td>Web Applications</td>
<td>3</td>
</tr>
<tr>
<td>CS 143</td>
<td>Compilers</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 144</td>
<td>Introduction to Computer Networking</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 145</td>
<td>Data Management and Data Systems</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 147</td>
<td>Introduction to Human-Computer Interaction Design</td>
<td>3-5</td>
</tr>
<tr>
<td>CS 148</td>
<td>Introduction to Computer Graphics and Imaging</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 149</td>
<td>Parallel Computing</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 154</td>
<td>Introduction to Automata and Complexity Theory</td>
<td>3-4</td>
</tr>
<tr>
<td>CS 155</td>
<td>Computer and Network Security</td>
<td>3</td>
</tr>
<tr>
<td>CS 157</td>
<td>Computational Logic</td>
<td>3</td>
</tr>
<tr>
<td>CS 161</td>
<td>Design and Analysis of Algorithms</td>
<td>3-5</td>
</tr>
<tr>
<td>CS 170</td>
<td>Stanford Laptop Orchestra: Composition, Coding, and Performance</td>
<td>1-5</td>
</tr>
<tr>
<td>CS 181</td>
<td>Computers, Ethics, and Public Policy</td>
<td>4</td>
</tr>
<tr>
<td>MATH 104</td>
<td>Applied Matrix Theory</td>
<td>3</td>
</tr>
<tr>
<td>MATH 113</td>
<td>Linear Algebra and Matrix Theory</td>
<td>3</td>
</tr>
<tr>
<td>STATS 116</td>
<td>Theory of Probability</td>
<td>4</td>
</tr>
</tbody>
</table>

1. Students who replace STATS 116 with STATS 217 must take a second course in Stochastic Processes or Probability.
2. Enrollment in STATS 116 after successful completion of STATS 217, 218, and/or 219, may not be used to fulfill degree requirements, including as an elective.
3. Students admitted to the Statistics M.S. program prior to academic year 2018-19 fulfill the requirements in effect at the time of their admission.
4. Enrollment in a course that provides redundant coursework cannot be used to fulfill the M.S. degree requirements.

**Master of Science in Statistics, Data Science Track**

The Data Science track develops strong mathematical, statistical, and computational and programming skills through the general master’s core and programming requirements. In addition, it provides a fundamental data science education through general and focused electives requirement from courses in data sciences and related areas. Course choices are limited to predefined courses from the data sciences and related courses group. The final requirement is a practical component to be completed through capstone project, data science clinic, or other courses that have strong hands-on or practical component, such as statistical consulting.

**Admission**

Prospective applicants should consult the Graduate Admissions (https://studentaffairs.stanford.edu/gradadmissions) and the Statistics Department admissions webpages (https://statistics.stanford.edu/admissions/graduate-application-information-and-instructions) for complete information on admission requirements and deadlines. Applicants apply to the Master of Science degree program in Statistics and subsequently declare their preference for the Data Science track (subplan) within the graduate application (“Department Specialization” option).

**Prerequisites**

Recommended preparatory courses include advanced undergraduate level courses in linear algebra and probability, and introductory courses in stochastic processes, numerical methods and proficiency in programming (Basic usage of the Python and C/C++ programming languages).

**Curriculum and Degree Requirements**

As defined in the general graduate student requirements, students must maintain a grade point average (GPA) of 3.0 or better and classes must be taken at the 200 level or higher. Students must complete 45 units of required coursework in Data Science.

**Master's Degree Program Proposal**

The Statistics (Data Science) Master’s Degree Program Proposal form (https://statistics.stanford.edu/academic-programs/graduate-programs/ms-program-forms) must be signed and approved by the department’s student services administrator before submission to the student’s program adviser. This form is due no later than the end of the first quarter of enrollment in the program.

A revised program proposal must be submitted if degree plans change. There is no thesis requirement.

The Data Science track (subplan) is printed on the student transcript and diploma.

**Mathematical and Statistical Foundations (15 units)**

Students must demonstrate foundational knowledge in the field by completing the following 5 core courses. Courses in this area must be taken for letter grades.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATS 200</td>
<td>Introduction to Statistical Inference</td>
<td>3</td>
</tr>
<tr>
<td>STATS 203</td>
<td>Introduction to Regression Models and Analysis of Variance</td>
<td>3</td>
</tr>
<tr>
<td>STATS 315A</td>
<td>Modern Applied Statistics: Learning</td>
<td>3</td>
</tr>
<tr>
<td>CME 302</td>
<td>Numerical Linear Algebra</td>
<td>3</td>
</tr>
<tr>
<td>CME 308</td>
<td>Stochastic Methods in Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

**Scientific Computing (9 units)**

To ensure students gain a strong foundation in strong scientific computing (6 units) and in large-scale computing (3 units). Courses in this area must be taken for letter grades.
Students are required to take two (2) courses that qualify as practicum that may include any combination of:

- Project labs offered by ENGR 150 Data Challenge Lab and ENGR 350 Data Impact Lab (Both have a limited enrollment and require an application to enroll.)
- A capstone project, supervised by a faculty member and approved by the student’s adviser. The research project should be computational in nature. Students should submit a one-page proposal, supported by the faculty member and sent to the student’s Data Science adviser for approval (at least one quarter prior to start of project). Should be taken for a letter grade.
- Master’s research: STATS 299 Independent Study.

5 Students admitted to the Statistics M.S. program prior to academic year 2018-19 fulfill the requirements in effect at the time of their admission.

Doctor of Philosophy in Statistics

The department looks for students who wish to prepare for research careers in statistics or probability, either applied or theoretical. Advanced undergraduate or master’s level work in mathematics and statistics provides a good background for the doctoral program. Quantitatively oriented students with degrees in other scientific fields are also encouraged to apply for admission. The program normally takes five years to complete.

Program Summary

First-year core program

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATS 300A</td>
<td>3</td>
</tr>
<tr>
<td>STATS 300B</td>
<td>3</td>
</tr>
<tr>
<td>STATS 300C</td>
<td>3</td>
</tr>
<tr>
<td>STATS 305A</td>
<td>3</td>
</tr>
<tr>
<td>STATS 305B</td>
<td>3</td>
</tr>
<tr>
<td>STATS 305C</td>
<td>3</td>
</tr>
<tr>
<td>STATS 310A</td>
<td>3</td>
</tr>
<tr>
<td>STATS 310B</td>
<td>3</td>
</tr>
<tr>
<td>STATS 310C</td>
<td>3</td>
</tr>
<tr>
<td>STATS 302</td>
<td>5-10</td>
</tr>
</tbody>
</table>

- Pass two of three parts of the qualifying examinations (end of first year); breadth requirement (second, third and fourth year); successfully complete the dissertation proposal meeting (early spring quarter of third year); pass the University oral examination (fourth or fifth year); dissertation (fifth year).
- In addition, students are required to take nine units of advanced topics courses offered by the department. Recommended courses include the following:

Electives (3 units)

In consultation with the student’s program adviser, choose a course (minimum of one) in scientific or engineering application area of interest.

Other courses that provides strong, firsthand experience with applications to actual data sets, such as STATS 390 Consulting Workshop.

Statistics

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>STATS 311</td>
<td>3</td>
</tr>
<tr>
<td>STATS 314A</td>
<td>3</td>
</tr>
<tr>
<td>STATS 315A</td>
<td>3</td>
</tr>
<tr>
<td>STATS 315B</td>
<td>3</td>
</tr>
<tr>
<td>STATS 317</td>
<td>3</td>
</tr>
<tr>
<td>STATS 318</td>
<td>3</td>
</tr>
<tr>
<td>STATS 322</td>
<td>3</td>
</tr>
<tr>
<td>STATS 325</td>
<td>3</td>
</tr>
<tr>
<td>STATS 350</td>
<td>1-3</td>
</tr>
<tr>
<td>STATS 359</td>
<td>3</td>
</tr>
<tr>
<td>STATS 362</td>
<td>3</td>
</tr>
<tr>
<td>STATS 367</td>
<td>3</td>
</tr>
<tr>
<td>STATS 370</td>
<td>3</td>
</tr>
<tr>
<td>EE 364A</td>
<td>3</td>
</tr>
<tr>
<td>EE 364B</td>
<td>3</td>
</tr>
</tbody>
</table>

- Take STATS 390 Consulting Workshop at least twice in years two and three.
• Take STATS 319 Literature of Statistics once per year after passing the Qualifying Exam until the year after passing the dissertation proposal meeting.

First-Year Core Courses
• STATS 300A Theory of Statistics I, STATS 300B Theory of Statistics II and STATS 300C Theory of Statistics III systematically survey the ideas of estimation and of hypothesis testing for parametric and nonparametric models involving small and large samples.
• STATS 305A Applied Statistics I is concerned with linear regression and the analysis of variance.
• STATS 305B Applied Statistics II and STATS 305C Applied Statistics III survey a large number of modeling techniques, related to but going beyond the linear models of STATS 305A Applied Statistics I.
• STATS 310A Theory of Probability I, STATS 310B Theory of Probability II, and STATS 310C Theory of Probability III are measure-theoretic courses in probability theory, beginning with basic concepts of the law of large numbers and martingale theory.

Students who do not have enough mathematics background can take STATS 310A,B,C after their first year but need to have their first-year program approved by the Director of Graduate Studies.

Qualifying Examinations
These are intended to test the student’s level of knowledge when the first-year program, common to all students, has been completed. There are separate examinations in the three core subjects of statistical theory and methods, applied statistics, and probability theory, and all are typically taken during the summer between the student’s first and second years. Students are expected to show acceptable performance in two examinations. Letter grades are not given. After passing the qualifying exams students file for Ph.D. candidacy, a University milestone.

Breadth Requirement
Students are required to take 15 units of coursework outside of the department and are advised to choose an area of concentration in a specific scientific field of statistical applications approved by their Ph.D. program adviser.


Dissertation Reading Committee, Dissertation Proposal Meeting and University Oral Examinations
The dissertation reading committee consists of the student’s adviser plus two faculty readers, all of whom are responsible for reading and approving the full dissertation.

The dissertation proposal meeting is intended to demonstrate students’ depth in some areas of statistics, and to examine the general plan for their research. It also confirms that students have chosen a Ph.D. faculty adviser and have started to work with that adviser on a research topic. In the meeting, the student will give a 60-minute presentation and discuss their ideas for completing a Ph.D. thesis, with a committee typically consisting of the members of the dissertation reading committee. The meeting must be successfully completed by early spring quarter of the third year. “Successful completion” means that the general research plan is sound and has a reasonable chance of success. If the student does not pass, the meeting must be repeated. Repeated failure by the end of Year 3 can lead to a loss of financial support.

The oral examination/dissertation defense is scheduled when the student has finished their dissertation and is in the process of completing their final draft. The oral exam consists of a 60-minute presentation on the dissertation topic, followed by a question and answer period attended only by members of the examining committee. The questions relate both to the student’s presentation and also explore the student’s familiarity with broader statistical topics related to the thesis research. The oral examination is normally completed within the last few months of the student’s Ph.D. period. The examining committee usually consists of at least five members: four examiners including the three members of the Dissertation Reading Committee, plus an outside chair who serves as an impartial representative of the academic standards of the University. Four out of five passing votes are required and no grades are given. Nearly all students can expect to pass this examination, although it is common for specific recommendations to be made regarding completion of the written dissertation.

For further information on University oral examinations and committees, see the Graduate Academic Policies and Procedures (GAP) Handbook, section 4.7 (http://gap.stanford.edu/4-7.html) or the “University Oral Examination (http://exploredegrees.stanford.edu/graduatedegrees/#doctoraltex)” section of this bulletin.

Doctoral and Research Advisers
From the student’s arrival until the selection of a research adviser, the student’s academic progress is monitored by the department’s Director of Graduate Studies. Each student should meet at least once a quarter with the Doctoral Adviser to discuss their academic plans and their progress towards choosing a dissertation adviser. See Graduate Advising Expectations section for more information.

Financial Support
Students accepted to the Ph.D. program are offered financial support. All tuition expenses are paid and there is a fixed monthly stipend determined to be sufficient to pay living expenses. Financial support can be continued for five years, department resources permitting, for students in good standing. The resources for student financial support derive from funds made available for student teaching and research assistantships. Students receive both a teaching and research assignment each quarter which, together, do not exceed 20 hours. Students are encouraged to apply for outside scholarships, fellowships, and other forms of financial support.

Ph.D. Minor in Statistics
Students must complete a total of 30 units for the Ph.D. minor. 20 units must be from Statistics courses numbered 300 and above and taken for a letter grade (minimum grade of B for each course). The remaining 10 units can be from Statistics courses numbered 200 and above, and may be taken for a letter grade or credit. Students may not include more than one unit of Stats 390, Consulting Workshop, towards the 30 units. The selection of courses must be approved by the Statistics Department and the Application for the Ph.D. Minor form must be approved by both the student’s Ph.D. department and the Statistics department.

For further information about the Statistics Ph.D. degree program requirements, see the department web site (https://statistics.stanford.edu/academics/doctoral-program).

Graduate Advising Expectations
The Department of Statistics is committed to providing academic advising in support of graduate student scholarly and professional development. When most effective, this advising relationship entails collaborative and sustained engagement by both the adviser and the advisee. As a best practice, advising expectations should be periodically discussed and reviewed to ensure mutual understanding. Both the adviser and the advisee are expected to maintain professionalism and integrity.

Faculty advisers guide students in key areas such as selecting courses, designing and conducting research, developing of teaching pedagogy,
navigating policies and degree requirements, and exploring academic opportunities and professional pathways.

Graduate students are active contributors to the advising relationship, proactively seeking academic and professional guidance and taking responsibility for informing themselves of policies and degree requirements for their graduate program.

For a statement of University policy on graduate advising, see the "Graduate Advising (http://exploredegrees.stanford.edu/graduatedegrees/#advisingandcredentialstext)” section of this bulletin.

M.S. in Statistics and Data Science

Master’s students are assigned an academic adviser for the duration of their tenure in the program. The adviser serves as a key resource for the purposes of course placement and approval of elective coursework as it relates to fulfilling degree requirements. Since the majority of MS students choose employment in the field of industry (tech/programming), the program adviser may provide assistance with regards to internships and general professional opportunities. Those planning to apply to doctoral programs are also able to receive feedback on research opportunities.

Ph.D. in Statistics

First and second year students are advised on course selection and other academic matters by the Director of Graduate Studies who is available by appointment to consult with students about any graduate student related matter, including degree progress. The DGS also leads cohort-specific workshops addressing topics such as qualifying exams, adviser selection, oral exams and post-graduation placement.

By the final study list deadline of Spring Quarter of the second year students are expected to have selected a research adviser who later serves as their principal dissertation adviser. The dissertation adviser must be a member of the Academic Council, and may be from outside the department. Students may also opt to have two co-advisers rather than one principal adviser, which may include one from outside the department.

The adviser-student mentorship takes many different forms, including, but not limited to programmatic consultation and degree progress, and support and collaboration relating to research, conferences, publications, and academic and professional opportunities.

It is the responsibility of the student to meet with their adviser at least once per quarter during the academic year to discuss academic standing and graduate degree progress. In addition, the Director of Graduate Studies is always available to Ph.D. students for consultation.

Program requirements and milestones, as well as more detailed descriptions of the program’s expectations of advisers and students, are listed in the Stats Ph.D. Handbook, available on the department website. (https://statistics.sites.stanford.edu/stats-phd-handbook-2018-19)

Faculty

Emeriti: (Professors) Jerome H. Friedman, Paul Switzer

Chair: Art Owen

Director of Graduate Studies: Amir Dembo

Director of Undergraduate Studies: Guenther Walther


Assistant Professors: Guillaume Basse, John Duchi, Scott Linderman, Tengyu Ma, Julia Palacios, Dominik Rothenhäusler

Courtesy Professors: John Ioannidis, Hua Tang

Courtesy Associate Professors: David Rogosa, Lu Tian

Courtesy Assistant Professors: Mike Baiocchi, Percy Shuo Liang, Stefan Wager

Stein Fellows: Nicholas Cook, Xiang Zhu