

# Statistics

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Department Website: <http://www.stat.uchicago.edu>  
Program of Study

The modern science of statistics involves the development of principles and methods for modeling uncertainty, for designing experiments, surveys, and observational programs, and for analyzing and interpreting empirical data. Mathematics plays a major role in all areas of statistics, from probability theory to data analysis. Statistics is an appropriate field for students with strong mathematical and computational skills and an interest in applying these skills to problems in the natural and social sciences. A program leading to the bachelor's degree in Statistics offers coverage of the principles and methods of statistics in combination with solid training in mathematics and some additional training in computation. The major can provide appropriate preparation for graduate study in statistics or in other subjects with strong quantitative components. Students considering graduate study in statistics or related fields are encouraged to discuss their programs with the Departmental Adviser for Majors at an early stage, whether or not they plan to receive an undergraduate degree in Statistics.

Students who are majoring in other fields of study may also complete a minor in Statistics and are encouraged to discuss their course choices with the Departmental Adviser for Minors. Information on the minor follows the description of the major.

## General Course Information

Courses at the 20000 level are designed to provide instruction in statistics, probability, and statistical computation for students from all parts of the University. These courses differ in emphasis on theory or methods, in mathematical level, and in the direction of applications.

## Introductory Courses and Sequences

To begin their studies in statistics, students can choose from several courses. Students and College advisers are encouraged to contact the Departmental Adviser for Introductory Courses for advice on choosing an appropriate first course.

For students with little or no math background who do not intend to continue on to more advanced statistics courses, STAT 20000 Elementary Statistics is an introductory course that emphasizes concepts rather than statistical techniques. STAT 20000 Elementary Statistics may not be taken by students with credit for STAT 22000 Statistical Methods and Applications, STAT 23400 Statistical Models and Methods, or more advanced courses in the Department of Statistics. STAT 20000 Elementary Statistics does not count toward the major or minor in Statistics.

Students with at least MATH 13100 Elementary Functions and Calculus I or placement into MATH 15100 Calculus I are encouraged to take STAT 22000 Statistical Methods and Applications instead of STAT 20000 Elementary Statistics. Students with three quarters of calculus may choose either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods. Students may count either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods, but not both, toward the forty-two credits required for graduation.

STAT 22000 Statistical Methods and Applications is a general introduction to statistical concepts, techniques, and applications to data analysis and to problems in the design, analysis, and interpretation of experiments and observational programs. A score of 5 on the AP Statistics exam yields credit for STAT 22000 Statistical Methods and Applications, although this credit will not count toward the requirements for a major or minor in Statistics. STAT 22000 Statistical Methods and Applications can count toward the minor in Statistics, but for students matriculating in Autumn Quarter 2016 and after, cannot count toward the major in Statistics.

STAT 23400 Statistical Models and Methods covers much of the same material as STAT 22000 Statistical Methods and Applications, but at a somewhat higher mathematical level. The course is a one-quarter introduction to statistics that is appropriate for any student with a good command of univariate calculus including sequences and series. STAT 23400 Statistical Models and Methods can count toward the minor in Statistics, but for students matriculating in Autumn Quarter 2016 and after, cannot count toward the major in Statistics.

STAT 24400-24500 Statistical Theory and Methods I-II is recommended for students who wish to have a thorough introduction to statistical theory and methodology. STAT 24400-24500 Statistical Theory and Methods I-II is more mathematically demanding than either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods. STAT 24400 Statistical Theory and Methods I assumes some familiarity with multivariate calculus, and STAT 24500 Statistical Theory and Methods II assumes some familiarity with linear algebra.

STAT 24410-24510 Statistical Theory and Methods Ia-IIa is an alternative version of STAT 24400-24500 Statistical Theory and Methods I-II that requires STAT 25100 Introduction to Mathematical Probability (or STAT 25150 Introduction to Mathematical Probability-A) as a prerequisite and that replaces some probability topics with additional statistical topics not normally covered in STAT 24400-24500 Statistical Theory and Methods I-II. STAT 24410-24510 Statistical Theory and Methods Ia-IIa is particularly well-suited for students with a strong mathematical background who are interested in more extensive coverage of probability and statistics. Students may count either STAT 24400 Statistical Theory and Methods I or STAT 24410 Statistical Theory and Methods Ia, but not both, toward the 4200 units of credit required for graduation. Similarly, students may count either STAT 24500 Statistical Theory and Methods II or STAT 24510 Statistical Theory

and Methods Iia, but not both, and they may count STAT 25100 Introduction to Mathematical Probability or STAT 25150 Introduction to Mathematical Probability-A, but not both, toward the 4200 units of credits required for graduation.

Students considering a major in Statistics are encouraged to begin with either STAT 24400-24500 Statistical Theory and Methods I-II or with the alternative sequence consisting of STAT 25100 Introduction to Mathematical Probability and STAT 24410-24510 Statistical Theory and Methods Ia-IIa, rather than with STAT 23400 Statistical Models and Methods. Although students with a strong mathematical background can and do take either STAT 24400-24500 Statistical Theory and Methods I-II or the alternative sequence (STAT 25100 Introduction to Mathematical Probability and STAT 24410-24510 Statistical Theory and Methods Ia-IIa) without prior course work in statistics or probability, some students find it helpful to take either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods as preparation.

The core of the Statistics major consists of three courses: STAT 25100 Introduction to Mathematical Probability and either STAT 24400-24500 Statistical Theory and Methods I-II or STAT 24410-24510 Statistical Theory and Methods Ia-IIa. Either of these is recommended as a three-quarter cognate sequence for students in the quantitative sciences and mathematics. Note that STAT 25100 Introduction to Mathematical Probability may be taken before, after, or concurrently with STAT 24400-24500 Statistical Theory and Methods I-II, though it is a prerequisite for STAT 24410-24510 Statistical Theory and Methods Ia-IIa.

### Additional Courses in Statistical Theory, Methods, and Applications

For students interested in continuing their study of statistics beyond the introductory level, STAT 22200 Linear Models and Experimental Design, STAT 22400 Applied Regression Analysis, STAT 22600 Analysis of Categorical Data, STAT 22700 Biostatistical Methods, and STAT 26700 History of Statistics are recommended. Note that because there is some overlap between STAT 22600 Analysis of Categorical Data and STAT 22700 Biostatistical Methods, only one of these two courses, not both, may be counted toward a major or minor in Statistics. The courses STAT 22200 Linear Models and Experimental Design, STAT 22400 Applied Regression Analysis, STAT 22600 Analysis of Categorical Data, and STAT 26700 History of Statistics may be taken in any order. Each presumes two quarters of calculus (except STAT 26700 History of Statistics) and a previous course in statistics (STAT 22000 Statistical Methods and Applications or higher). STAT 22700 Biostatistical Methods has STAT 22400 Applied Regression Analysis as a prerequisite.

For students who have completed STAT 24400-24500 Statistical Theory and Methods I-II and are interested in more advanced statistical methodology courses, STAT 24620 Multivariate Statistical Analysis: Applications and Techniques, STAT 26100 Time Dependent Data, STAT 27400 Nonparametric Inference, STAT 27850 Multiple Testing, Modern Inference, and Replicability, and STAT 34300 Applied Linear Statistical Methods are recommended. Many other graduate courses in Statistics offer opportunities for further study of statistical theory, methods, and applications. For details, consult the instructor or the Departmental Adviser for Majors, or visit the Graduate Announcements (<http://graduateannouncements.uchicago.edu/departamentofstatistics>).

### Courses in Probability

Students interested in probability can begin with STAT 25100 Introduction to Mathematical Probability, which can be taken separately from any Statistics courses and can be supplemented with more advanced probability courses, such as STAT 25300 Introduction to Probability Models or MATH 23500 Markov Chains, Martingales, and Brownian Motion. Students with a strong mathematical background can take STAT 31200 Introduction to Stochastic Processes I, STAT 38100 Measure-Theoretic Probability I, and STAT 38300 Measure-Theoretic Probability III. Note that because there is some overlap between MATH 23500 Markov Chains, Martingales, and Brownian Motion and STAT 31200 Introduction to Stochastic Processes I, only one of these two courses, not both, may be counted toward a major in Statistics.

### Courses in Machine Learning

A student with a strong computer science background and some knowledge of elementary statistics could take STAT 27725 Machine Learning. Other courses in the category of machine learning include the advanced statistical methodology courses STAT 24620 Multivariate Statistical Analysis: Applications and Techniques and STAT 27400 Nonparametric Inference. Graduate course offerings in machine learning include STAT 37601 Machine Learning and Large-Scale Data Analysis and STAT 37710 Machine Learning.

### Courses in Optimization

A student with a strong mathematical background could take STAT 28000 Optimization. Graduate course offerings in optimization include STAT 31015 Mathematical Computation IIA: Convex Optimization.

### Grading

Students who are majoring or minoring in Statistics must receive a quality grade of at least C+ in all of the courses counted toward their major or minor program in Statistics. In addition, students who are majoring in Statistics must receive quality grades of at least B- in both STAT 24400 Statistical Theory and Methods I and STAT 24500 Statistical Theory and Methods II (or at least C+ in both STAT 24410 Statistical Theory and Methods Ia and STAT 24510 Statistical Theory and Methods Iia). Subject to College and divisional regulations, and with the consent of the instructor, students may register for either quality grades or for P/F grading in any 20000-level Statistics course that is not counted toward a major or minor in Statistics. A grade of P is given only for work of C- quality or higher.

The following policy applies to students who wish to receive a mark of I for a Statistics course. In addition to submitting the official Incomplete Form required by the College, students must have completed at least half of the total

required course work with a grade of C- or better, and they must be unable to complete the remaining course work by the end of the quarter due to an emergency. Students requesting a mark of I for STAT 20000 Elementary Statistics, STAT 22000 Statistical Methods and Applications, or STAT 23400 Statistical Models and Methods must obtain approval from both the current instructor and the Departmental Adviser for Introductory Courses.

### Program Requirements for Majors

The requirements for the BA and BS in Statistics have been updated in 2017. Students who matriculated prior to Autumn 2017 may choose to follow these updated requirements; otherwise, they should consult the archived catalog from their year of matriculation (or, at their option, any later year) for the degree requirements in Statistics. All students who matriculated in Autumn 2017 or later should follow the updated requirements described below.

Every candidate must obtain approval of his or her course program from the Departmental Adviser for Majors. Students majoring in Statistics should meet the general education requirement in mathematical sciences with courses in calculus. The major program includes four additional prescribed mathematics courses, four prescribed statistics courses, and two prescribed computer science courses. Students are advised to complete the four mathematics courses by the end of their third year. Additional requirements include four approved elective courses in Statistics. The BS also requires an additional prescribed mathematics course and an approved, coherent, three-quarter sequence at the 20000 level in a field to which statistics can be applied. Students who are majoring in Statistics must receive quality grades of at least B- in both STAT 24400 Statistical Theory and Methods I and STAT 24500 Statistical Theory and Methods II (or at least C+ in both STAT 24410 Statistical Theory and Methods Ia and STAT 24510 Statistical Theory and Methods IIa), and at least C+ in all other courses counted toward the Statistics major. A grade of P is not acceptable for any of these courses.

### Prescribed Mathematics Courses

The prescribed mathematics courses include a Calculus III requirement (MATH 13300 Elementary Functions and Calculus III or MATH 15300 Calculus III or MATH 16300 Honors Calculus III) and a Linear Algebra requirement (STAT 24300 Numerical Linear Algebra or MATH 20250 Abstract Linear Algebra). Note that MATH 19620 Linear Algebra may not be used to meet the Linear Algebra requirement.

For the BA, one of the following pairs of courses is required: MATH 20000-20100 Mathematical Methods for Physical Sciences I-II or MATH 20400-20500 Analysis in Rn II-III or MATH 20800-20900 Honors Analysis in Rn II-III or the pair consisting of MATH 20000 Mathematical Methods for Physical Sciences I and STAT 28200 Dynamical Systems with Applications.

For the BS, students must take one of the following three courses: MATH 20000 Mathematical Methods for Physical Sciences I or MATH 20500 Analysis in Rn III or MATH 20900 Honors Analysis in Rn III; and, in addition, one of the following three courses: MATH 20100 Mathematical Methods for Physical Sciences II, MATH 27300 Basic Theory of Ordinary Differential Equations, or STAT 28200 Dynamical Systems with Applications; and, in addition, one of the following two courses: STAT 28000 Optimization or MATH 21100 Basic Numerical Analysis.

Students who are completing majors in both Statistics and Economics should follow the same mathematics requirements as Statistics majors. Students who have already taken MATH 19520 Mathematical Methods for Social Sciences and MATH 19620 Linear Algebra should discuss with the Departmental Adviser for Majors how best to meet the mathematics requirements for the Statistics major. For example, such students can petition to meet the requirements for the BA in Statistics by taking all three of MATH 20100 Mathematical Methods for Physical Sciences II, STAT 24300 Numerical Linear Algebra, and STAT 28200 Dynamical Systems with Applications.

### Prescribed Statistics Courses

The four prescribed Statistics courses are STAT 25100 Introduction to Mathematical Probability, STAT 24400-24500 Statistical Theory and Methods I-II (or STAT 24410-24510 Statistical Theory and Methods Ia-IIa), and either STAT 22400 Applied Regression Analysis or STAT 34300 Applied Linear Statistical Methods.

It is recommended that students who have had some multivariable calculus begin the major by taking either STAT 25100 Introduction to Mathematical Probability or STAT 24400 Statistical Theory and Methods I as their first course in probability and statistics. An alternative route to beginning the major would be to first take either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods, neither of which count toward the major, but which could serve as a prerequisite for courses such as STAT 22400 Applied Regression Analysis, STAT 22200 Linear Models and Experimental Design, and STAT 22600 Analysis of Categorical Data, which do count toward the major. This second path is recommended for students who need additional time to complete multivariable calculus and linear algebra prerequisites and who want to get started on the major in the meantime.

### Electives

Candidates for the BA are required to take four electives, at least two of which must be on List B below. The remaining two electives may be from either List B or C. Students may count either STAT 22600 Analysis of Categorical Data or STAT 22700 Biostatistical Methods, but not both, toward the BA. Similarly, students may count either MATH 23500 Markov Chains, Martingales, and Brownian Motion or STAT 31200 Introduction to Stochastic Processes I, but not both, toward the BA.

Candidates for the BS are required to take four electives. A candidate for the BS who has *not* taken STAT 34300 Applied Linear Statistical Methods as one of the four prescribed statistics courses must take at least one elective from List A below, a second elective from List B, and the remaining two electives may be from either List B or C. A candidate for the

BS who *has* taken STAT 34300 Applied Linear Statistical Methods as one of the four prescribed statistics courses must take at least two electives from List B and the remaining two electives may be from either List B or C. For the BS in Statistics, STAT 28000 Optimization counts as a List C elective only if MATH 21100 Basic Numerical Analysis is also included in the program. In other words, students cannot double-count STAT 28000 Optimization toward both the four-elective requirement and the requirement to take one of STAT 28000 Optimization and MATH 21100 Basic Numerical Analysis. Students may count either STAT 22600 Analysis of Categorical Data or STAT 22700 Biostatistical Methods, but not both, toward the BS. Similarly, students may count either MATH 23500 Markov Chains, Martingales, and Brownian Motion or STAT 31200 Introduction to Stochastic Processes I, but not both, toward the BS.

Note: The following lists may change from time to time as courses change and new courses are added. Please consult the Departmental Adviser for Majors for approval of your electives.

#### LIST A: Advanced Statistical Methodology

|  |  |
|--|--|
| STAT 24620   | Multivariate Statistical Analysis: Applications and Techniques |
| STAT 26100   | Time Dependent Data  |
| STAT 27400   | Nonparametric Inference  |
| STAT 27850   | Multiple Testing, Modern Inference, and Replicability          |
| Some additional graduate courses in Statistics (must be approved by Departmental Adviser for Majors) |  |

#### LIST B: Statistical Methodology

|  |  |
|--|--|
| STAT 22200   | Linear Models and Experimental Design                          |
| STAT 22600   | Analysis of Categorical Data *                                 |
| STAT 22700   | Biostatistical Methods *                                       |
| STAT 24620   | Multivariate Statistical Analysis: Applications and Techniques |
| STAT 26100   | Time Dependent Data  |
| STAT 26700   | History of Statistics  |
| STAT 27400   | Nonparametric Inference  |
| STAT 27850   | Multiple Testing, Modern Inference, and Replicability          |
| STAT 35800   | Statistical Applications                                       |
| STAT 37601   | Machine Learning and Large-Scale Data Analysis                 |
| Some additional graduate courses in Statistics (must be approved by Departmental Adviser for Majors) |  |

\* Students may count either STAT 22600 Analysis of Categorical Data or STAT 22700 Biostatistical Methods, but not both, toward the major.

#### LIST C: Other Upper Level/Graduate Courses

|  |   |
|--|---|
| MATH 23500   | Markov Chains, Martingales, and Brownian Motion *                   |
| STAT 25300   | Introduction to Probability Models                                  |
| STAT 27725   | Machine Learning  |
| STAT 28000   | Optimization **   |
| STAT 30900   | Mathematical Computation I: Matrix Computation Course               |
| STAT 31015   | Mathematical Computation IIA: Convex Optimization                   |
| STAT 31020   | Mathematical Computation IIB: Nonlinear Optimization                |
| STAT 31060   | Further Mathematical Computation: Matrix Computation & Optimization |
| STAT 31200   | Introduction to Stochastic Processes I *                            |
| STAT 37710   | Machine Learning  |
| STAT 38100   | Measure-Theoretic Probability I                                     |
| STAT 38300   | Measure-Theoretic Probability III                                   |
| Some additional graduate courses in Statistics (must be approved by Departmental Adviser for Majors) |   |

\* Students may count either MATH 23500 Markov Chains, Martingales, and Brownian Motion or STAT 31200 Introduction to Stochastic Processes I, but not both, toward the major.

\*\* For the BA in Statistics, STAT 28000 Optimization counts as a List C elective. For the BS in Statistics, STAT 28000 Optimization counts as a List C elective only if MATH 21100 Basic Numerical Analysis is also included in the program. In other words, for the BS, students cannot double-count STAT 28000 Optimization toward both the four-elective requirement and the requirement to take at least one of STAT 28000 Optimization and MATH 21100 Basic Numerical Analysis.

**Computer Science Requirement**

Candidates for either the BA or the BS are required to take one of the following sequences: CMSC 12100-12200 Computer Science with Applications I-II or CMSC 15100-15200 Introduction to Computer Science I-II or CMSC 16100-16200 Honors Introduction to Computer Science I-II.

**BS Requirement of Three-Quarter Sequence in a Field to Which Statistics Can Be Applied**

Candidates for the BS (but not the BA) are required to take an approved, coherent, three-quarter sequence at the 20000 level in a field to which statistics can be applied. Generally this sequence should be in the natural or social sciences, but a sequence in another discipline may be acceptable. Courses in MATH or CMSC may not be used for this requirement. Sequences in which earlier courses are prerequisites for later ones are preferred. Example sequences include BIOS 20198 Biodiversity-BIOS 20196 Ecology and Conservation-BIOS 23406 Biogeography; CHEM 22000-22100-22200 Organic Chemistry I-II-III; CHEM 26100-26200-26300 Quantum Mechanics; Thermodynamics; Chemical Kinetics and Dynamics; ECON 20000-20100-20200 The Elements of Economic Analysis I-II-III; GEOS 21000 Mineralogy-GEOS 21100 Introduction to Petrology-GEOS 21200 Physics of the Earth; and PHYS 23400-23500 Quantum Mechanics I-II-PHYS 23700 Nuclei and Elementary Particles. All sequences must be approved by the Departmental Adviser for Majors.

**Summary of Requirements for the BA in Statistics**

**GENERAL EDUCATION**

|                                   |  |     |
|-----------------------------------|--|-----|
| One of the following sequences: * |  | 200 |
| MATH 13100-13200                  | Elementary Functions and Calculus I-II |     |
| MATH 15100-15200                  | Calculus I-II                          |     |
| MATH 16100-16200                  | Honors Calculus I-II                   |     |
| <hr/>                             |  |     |
| Total Units                       |  | 200 |

**MAJOR**

|   |  |      |
|---|--|------|
| One of the following: *                         |  | 100  |
| MATH 13300                                      | Elementary Functions and Calculus III  |      |
| MATH 15300                                      | Calculus III   |      |
| MATH 16300                                      | Honors Calculus III  |      |
| One of the following course pairs:              |  | 200  |
| MATH 20000 & STAT 28200                         | Mathematical Methods for Physical Sciences I and Dynamical Systems with Applications |      |
| MATH 20000-20100                                | Mathematical Methods for Physical Sciences I-II                                      |      |
| MATH 20400-20500                                | Analysis in $R^n$ II-III   |      |
| MATH 20800-20900                                | Honors Analysis in $R^n$ II-III  |      |
| One of the following:                           |  | 100  |
| STAT 24300                                      | Numerical Linear Algebra   |      |
| MATH 20250                                      | Abstract Linear Algebra  |      |
| One of the following sequences:                 |  | 200  |
| STAT 24400-24500                                | Statistical Theory and Methods I-II  |      |
| STAT 24410-24510                                | Statistical Theory and Methods Ia-IIa  |      |
| One of the following:                           |  | 100  |
| STAT 25100                                      | Introduction to Mathematical Probability   |      |
| STAT 25150                                      | Introduction to Mathematical Probability-A   |      |
| One of the following:                           |  | 100  |
| STAT 22400                                      | Applied Regression Analysis  |      |
| STAT 34300                                      | Applied Linear Statistical Methods   |      |
| One of the following sequences:                 |  | 200  |
| CMSC 12100-12200                                | Computer Science with Applications I-II  |      |
| CMSC 15100-15200                                | Introduction to Computer Science I-II  |      |
| CMSC 16100-16200                                | Honors Introduction to Computer Science I-II   |      |
| Four approved elective courses in Statistics ** |  | 400  |
| <hr/>   |  |      |
| Total Units                                     |  | 1400 |

\* Credit may be granted by examination.

\*\* At least two of the electives must be on List B. The remaining two electives may be from either List B or C. Students may count either STAT 22600 Analysis of Categorical Data or STAT 22700 Biostatistical Methods, but not both, toward the BA. Students may count either MATH 23500 Markov Chains, Martingales, and Brownian Motion or STAT 31200 Introduction to Stochastic Processes I, but not both, toward the BA.

### Summary of Requirements for the BS in Statistics

#### GENERAL EDUCATION

|                                   |  |     |
|-----------------------------------|--|-----|
| One of the following sequences: * |  | 200 |
| MATH 13100-13200                  | Elementary Functions and Calculus I-II |     |
| MATH 15100-15200                  | Calculus I-II                          |     |
| MATH 16100-16200                  | Honors Calculus I-II                   |     |
| Total Units                       |  | 200 |

#### MAJOR

|  |   |      |
|--|---|------|
| One of the following: *  |   | 100  |
| MATH 13300   | Elementary Functions and Calculus III           |      |
| MATH 15300   | Calculus III                                    |      |
| MATH 16300   | Honors Calculus III                             |      |
| One of the following:  |   | 100  |
| MATH 20000   | Mathematical Methods for Physical Sciences I    |      |
| MATH 20500   | Analysis in $\mathbb{R}^n$ III                  |      |
| MATH 20900   | Honors Analysis in $\mathbb{R}^n$ III           |      |
| One of the following:  |   | 100  |
| MATH 20100   | Mathematical Methods for Physical Sciences II   |      |
| MATH 27300   | Basic Theory of Ordinary Differential Equations |      |
| STAT 28200   | Dynamical Systems with Applications             |      |
| One of the following:  |   | 100  |
| STAT 24300   | Numerical Linear Algebra                        |      |
| MATH 20250   | Abstract Linear Algebra                         |      |
| One of the following:  |   | 100  |
| STAT 28000   | Optimization                                    |      |
| MATH 21100   | Basic Numerical Analysis                        |      |
| One of the following sequences:  |   | 200  |
| STAT 24400-24500   | Statistical Theory and Methods I-II             |      |
| STAT 24410-24510   | Statistical Theory and Methods Ia-IIa           |      |
| One of the following:  |   | 100  |
| STAT 25100   | Introduction to Mathematical Probability        |      |
| STAT 25150   | Introduction to Mathematical Probability-A      |      |
| One of the following:  |   | 100  |
| STAT 22400   | Applied Regression Analysis                     |      |
| STAT 34300   | Applied Linear Statistical Methods              |      |
| One of the following sequences:  |   | 200  |
| CMSC 12100-12200   | Computer Science with Applications I-II         |      |
| CMSC 15100-15200   | Introduction to Computer Science I-II           |      |
| CMSC 16100-16200   | Honors Introduction to Computer Science I-II    |      |
| Four approved elective courses in Statistics **  |   | 400  |
| A coherent three-quarter sequence at the 20000 level in a field to which statistics can be applied *** |   | 300  |
| Total Units  |   | 1800 |

\* Credit may be granted by examination.

- \*\* A candidate for the BS who has *not* taken STAT 34300 Applied Linear Statistical Methods as one of the four prescribed statistics courses must take at least one elective from List A, a second elective from List B, and the remaining two electives may be from either List B or C. A candidate for the BS who *has* taken STAT 34300 Applied Linear Statistical Methods as one of the four prescribed statistics courses must take at least two electives from List B and the remaining two electives may be from either List B or C. For the BS in Statistics, STAT 28000 Optimization counts as a List C elective only if MATH 21100 Basic Numerical Analysis is also included in the program. In other words, students cannot double-count STAT 28000 Optimization toward both the four-elective requirement and the requirement to take at least one of STAT 28000 Optimization and MATH 21100 Basic Numerical Analysis. Students may count either STAT 22600 Analysis of Categorical Data or STAT 22700 Biostatistical Methods, but not both, toward the BS. Students may count either MATH 23500 Markov Chains, Martingales, and Brownian Motion or STAT 31200 Introduction to Stochastic Processes I, but not both, toward the BS.
- \*\*\* Generally, this sequence should be in the natural or social sciences, but a sequence in another discipline may be acceptable. Courses in MATH or CMSC may not be used for this requirement. Sequences in which earlier courses are prerequisites for later ones are preferred. Example sequences include BIOS 20198 Biodiversity-BIOS 20196 Ecology and Conservation-BIOS 23406 Biogeography; CHEM 22000-22100-22200 Organic Chemistry I-II-III; CHEM 26100-26200-26300 Quantum Mechanics; Thermodynamics; Chemical Kinetics and Dynamics; ECON 20000-20100-20200 The Elements of Economic Analysis I-II-III; GEOS 21000 Mineralogy-GEOS 21100 Introduction to Petrology-GEOS 21200 Physics of the Earth; and PHYS 23400-23500 Quantum Mechanics I-II-PHYS 23700 Nuclei and Elementary Particles. All sequences must be approved by the Departmental Adviser for Majors.

## Honors

The BA or BS with honors is awarded to students with Statistics as their primary major who have a GPA of 3.0 or higher overall and 3.25 or higher in the courses in the major and also complete an approved honors paper (STAT 29900 Bachelor's Paper). This paper is typically based on a structured research program that the student undertakes, with faculty supervision, in the first quarter of his or her fourth year. Eligible students who wish to be considered for honors should consult the Departmental Adviser for Majors before the end of their third year. The research paper or project used to meet this requirement may not be used to meet the bachelor's paper or project requirement in another major or course. NOTE: Credit for STAT 29900 Bachelor's Paper will not count towards the courses required for a major in Statistics.

## Joint BA/MS or BS/MS in Statistics

This program enables unusually well-qualified undergraduate students to complete an MS in Statistics along with a BA or BS during their four years at the College. Although a student may receive a BA or BS in any field, a program of study other than Statistics is recommended.

Only a small number of students will be selected for the program through a competitive admissions process. Participants must apply to the MS program in Statistics by June 1 of their third year for admission to candidacy for an MS in Statistics during their fourth year. To be considered, students should have completed almost all of their undergraduate requirements, including all of their general education and language competence requirements, by the end of their third year. They should also have completed, at a minimum, STAT 24400-24500 Statistical Theory and Methods I-II (or STAT 24410-24510 Statistical Theory and Methods Ia-IIa) with A or A- grades and all the mathematics requirements for the Statistics major with very high grades. While these are the minimum criteria, admission is competitive, and additional qualifications may be needed. Interested students are strongly encouraged to consult both the Departmental Adviser for Majors and their College adviser early in their third year.

Participants in the joint BA/MS or BS/MS program must meet the same requirements as students in the MS program in Statistics. Of the nine courses that are required at the appropriate level, up to three may also meet the requirements of an undergraduate program. For example, STAT 24410-24510 Statistical Theory and Methods Ia-IIa and STAT 34300 Applied Linear Statistical Methods, which satisfy requirements for the MS in Statistics, could also be used to satisfy requirements of a BA or BS program in Statistics.

Other requirements include a master's paper and participation in the Consulting Program of the Department of Statistics. For details, visit the Department of Statistics Admissions page (<http://www.stat.uchicago.edu/admissions/> featured).

## Minor Program in Statistics

In contrast to the Statistics major, which has a substantial theoretical component, the Statistics minor focuses on statistical methodology. The minor in Statistics requires five courses, some prescribed and some elective, chosen in consultation with the Departmental Adviser for Minors. By the end of Spring Quarter of the student's third year, a student who wishes to complete the Statistics minor must complete the Consent to Complete a Minor form (<https://college.uchicago.edu/advising/forms-and-petitions>) and obtain approval from the Departmental Adviser for Minors.

The core of the Statistics minor consists of STAT 22400 Applied Regression Analysis and either STAT 22200 Linear Models and Experimental Design or STAT 22600 Analysis of Categorical Data (or both). All three courses may be taken in any order after meeting the prerequisite of at least two quarters calculus and introductory statistics: STAT 22000 Statistical Methods and Applications, STAT 23400 Statistical Models and Methods, STAT 24500 Statistical Theory and Methods II, STAT 24510 Statistical Theory and Methods Ia, or AP credit for STAT 22000 Statistical Methods and Applications.

An approved substitute for STAT 22600 Analysis of Categorical Data is STAT 22700 Biostatistical Methods, which has STAT 22400 Applied Regression Analysis as prerequisite and is offered by the Department of Public Health Sciences. Students may count either STAT 22600 Analysis of Categorical Data or STAT 22700 Biostatistical Methods, but not both, toward the Statistics minor.

In the Statistics minor, either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods, but not both, may be used as an elective if not used to fulfill a requirement for any major(s), other minors, or general education requirements and if taken prior to any other courses for which at least STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods is prerequisite. Students may not use AP credit for statistics to meet a requirement for the Statistics minor. If either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods are used to fulfill a requirement for any major(s), other minors, or general education requirements, then neither course may be used to fulfill a requirement in the Statistics minor.

No courses in the Statistics minor can be double counted with the student's major(s), other minors, or general education requirements. An approved elective must replace any course required for the Statistics minor that is used to meet the requirements for any major(s), other minors, or general education requirements.

The following 20000-level courses offered by the Department of Statistics *may not be included* in a Statistics minor: STAT 20000 Elementary Statistics, STAT 24300 Numerical Linear Algebra, STAT 24400 Statistical Theory and Methods I, STAT 24410 Statistical Theory and Methods Ia, STAT 25100 Introduction to Mathematical Probability, STAT 25150 Introduction to Mathematical Probability-A, STAT 25300 Introduction to Probability Models, STAT 27725 Machine Learning, STAT 28000 Optimization, STAT 28200 Dynamical Systems with Applications, or any graduate courses in probability.

Students who are minoring in Statistics must receive a quality grade of at least C+ in all of the courses counted toward the minor. A grade of P is not acceptable for any of these courses. More than half of the courses counted toward the Statistics minor must be met by registering for courses bearing University of Chicago course numbers. Students may not use AP credit for STAT 22000 Statistical Methods and Applications to meet a requirement for the Statistics minor.

#### Summary of Requirements for the Minor in Statistics

|                              |                                       |     |
|------------------------------|---------------------------------------|-----|
| The following course: *      |                                       | 100 |
| STAT 22400                   | Applied Regression Analysis           |     |
| One of the following: *      |                                       | 100 |
| STAT 22200                   | Linear Models and Experimental Design |     |
| STAT 22600                   | Analysis of Categorical Data **       |     |
| Three approved electives *** |                                       | 300 |
| Total Units                  |                                       | 500 |

\* STAT 22200 Linear Models and Experimental Design, STAT 22400 Applied Regression Analysis, and STAT 22600 Analysis of Categorical Data may be taken in any order after meeting the prerequisite of at least two quarters calculus and introductory statistics: STAT 22000 Statistical Methods and Applications, STAT 23400 Statistical Models and Methods, STAT 24500 Statistical Theory and Methods II, STAT 24510 Statistical Theory and Methods IIa, or AP credit for STAT 22000 Statistical Methods and Applications.

\*\* An approved substitute for STAT 22600 Analysis of Categorical Data is STAT 22700 Biostatistical Methods, which has STAT 22400 Applied Regression Analysis as prerequisite and is offered by the Department of Public Health Sciences. Students may count either STAT 22600 Analysis of Categorical Data or STAT 22700 Biostatistical Methods, but not both, toward the Statistics minor.

\*\*\* If STAT 22200 Linear Models and Experimental Design is used to fulfill a requirement of the Statistics minor, then STAT 22600 Analysis of Categorical Data may be used as an elective in the minor. Similarly, If STAT 22600 Analysis of Categorical Data is used to fulfill a requirement of the Statistics minor, then STAT 22200 Linear Models and Experimental Design may be used as an elective in the minor.

#### Departmental Electives Approved for the Minor in Statistics

|            |  |     |
|------------|--|-----|
| STAT 22000 | Statistical Methods and Applications <sup>1,2</sup>            | 100 |
| STAT 22200 | Linear Models and Experimental Design <sup>3</sup>             | 100 |
| STAT 22600 | Analysis of Categorical Data <sup>3</sup>                      | 100 |
| STAT 23400 | Statistical Models and Methods <sup>1</sup>                    | 100 |
| STAT 24500 | Statistical Theory and Methods II <sup>4</sup>                 | 100 |
| STAT 24510 | Statistical Theory and Methods IIa                             | 100 |
| STAT 26100 | Time Dependent Data  | 100 |
| STAT 24620 | Multivariate Statistical Analysis: Applications and Techniques | 100 |
| STAT 26700 | History of Statistics  | 100 |
| STAT 27400 | Nonparametric Inference  | 100 |
| STAT 27850 | Multiple Testing, Modern Inference, and Replicability          | 100 |



|            |                             |     |
|------------|-----------------------------|-----|
| STAT 33100 | Sample Surveys <sup>5</sup> | 100 |
|------------|-----------------------------|-----|

- 1 Either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods, but not both, may be used as an elective if not used to fulfill a requirement for any major(s), other minors, or general education requirements and if taken prior to any other courses for which at least STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods is prerequisite. If either STAT 22000 Statistical Methods and Applications or STAT 23400 Statistical Models and Methods is used to fulfill a requirement for any major(s), other minors, or general education requirements, then neither course may be used to fulfill a requirement in the Statistics minor.
- 2 Students may not use AP credit for STAT 22000 Statistical Methods and Applications to meet a requirement for the Statistics minor.
- 3 If either STAT 22200 Linear Models and Experimental Design is used to fulfill a requirement of the Statistics minor, then STAT 22600 Analysis of Categorical Data may be used as an elective in the minor. Similarly, if STAT 22600 Analysis of Categorical Data is used to fulfill a requirement of the Statistics minor, then STAT 22200 Linear Models and Experimental Design may be used as an elective in the minor.
- 4 If either STAT 24500 Statistical Theory and Methods II or STAT 24510 Statistical Theory and Methods IIa is used as an elective in the Statistics minor, then the prerequisite STAT 24400 Statistical Theory and Methods I or STAT 24410 Statistical Theory and Methods Ia may not be counted toward the minor, but may be counted toward any major(s) or other minors.
- 5 Undergraduate registration in 30000-level and 40000-level courses is by instructor consent only. Students should contact the instructor well in advance.

#### Other Electives Approved for the Minor in Statistics

Because of the interdisciplinary nature of the College, the Divisions, and the field of statistics, other departments and committees offer courses approved for use as electives for the Statistics minor. Please consult the Departmental Adviser for Minors for a current list of approved courses. Offering departments include Public Health Sciences, Computer Science, Comparative Human Development, Human Genetics, Sociology, and the University of Chicago Booth School of Business. Some of these courses bear a Statistics course number and some do not. Some courses are at the 30000 or 40000 level, which require instructor consent for undergraduate registration. Students should contact the instructor well in advance.

The list of courses approved for the Statistics minor may change from time to time as courses change and new courses are added. Please consult the Departmental Adviser for Minors for approval of your minor program plan. Students may petition the Departmental Adviser for Minors for approval of another course. Such courses must have a minimum statistics prerequisite of introductory statistics (STAT 22000 Statistical Methods and Applications, STAT 23400 Statistical Models and Methods, STAT 24500 Statistical Theory and Methods II, or STAT 24510 Statistical Theory and Methods IIa) and cannot substantially overlap with the topics covered in departmental courses or other courses in the student's minor program.

**College-level Statistics courses are shown below. Graduate-level courses can be found on the Department of Statistics page of the Graduate Announcements (<http://graduateannouncements.uchicago.edu/graduate/departamentofstatistics>).**





### Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Trajan.

Times was used instead of Palatino.

The editor may contact Leepfrog for a draft with the correct fonts in place.