DATA SCIENCE MAJOR

Students must also complete the Undergraduate Registration Requirement (https://catalogs.northwestern.edu/undergraduate/requirements-policies/undergraduate-registration-requirement/) and the degree requirements of their home school.

Course Department Courses (11 units)

4 foundational courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 202-0</td>
<td>Introduction to Statistics and Data Science</td>
</tr>
<tr>
<td>or STAT 210-0</td>
<td>Introduction to Probability and Statistics</td>
</tr>
<tr>
<td>or STAT 232-0</td>
<td>Applied Statistics</td>
</tr>
<tr>
<td>STAT 228-0</td>
<td>Series and Multiple Integrals</td>
</tr>
<tr>
<td>or MATH 226-0</td>
<td>Sequences and Series</td>
</tr>
<tr>
<td>&amp; MATH 230-2</td>
<td>and Multivariable Integral Calculus</td>
</tr>
</tbody>
</table>

or

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 301-1</td>
<td>Data Science 1 with Python</td>
</tr>
<tr>
<td>&amp; STAT 301-2</td>
<td>and Data Science 2 with Python</td>
</tr>
<tr>
<td>&amp; STAT 303-3</td>
<td>and Data Science 3 with Python</td>
</tr>
</tbody>
</table>

NOTE! Students may receive credit for only one Data Science sequence: either Data Science with R (301 sequence), or Data Science with Python (303 sequence)

6 data science core courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 301-1</td>
<td>Data Science 1 with R</td>
</tr>
<tr>
<td>&amp; STAT 301-2</td>
<td>and Data Science 2 with R</td>
</tr>
<tr>
<td>&amp; STAT 303-1</td>
<td>and Data Science 3 with R</td>
</tr>
</tbody>
</table>

or

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 302-1</td>
<td>Statistical Theory &amp; Methods 1</td>
</tr>
<tr>
<td>STAT 302-2</td>
<td>Statistical Theory &amp; Methods 2</td>
</tr>
</tbody>
</table>

1 capstone experience course:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 390-0</td>
<td>Data Science Project</td>
</tr>
</tbody>
</table>

Required Related Courses (8 units)

4 mathematics courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 220-1</td>
<td>Single-Variable Differential Calculus</td>
</tr>
<tr>
<td>&amp; MATH 220-2</td>
<td>and Single-Variable Integral Calculus</td>
</tr>
<tr>
<td>or MATH 218-1</td>
<td>Single-Variable Calculus with Precalculus</td>
</tr>
<tr>
<td>&amp; MATH 218-2</td>
<td>and Single-Variable Calculus with Precalculus</td>
</tr>
<tr>
<td>&amp; MATH 218-3</td>
<td>and Single-Variable Calculus with Precalculus</td>
</tr>
</tbody>
</table>

or

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 230-1</td>
<td>Multivariable Differential Calculus</td>
</tr>
<tr>
<td>or MATH 228-1</td>
<td>Multivariable Differential Calculus for Engineering</td>
</tr>
<tr>
<td>or MATH 281-1</td>
<td>Accelerated Mathematics for ISP: First Year</td>
</tr>
<tr>
<td>or MATH 285-2</td>
<td>Accelerated Mathematics for MMSS: First Year</td>
</tr>
<tr>
<td>or MATH 290-2</td>
<td>MENU: Linear Algebra and Multivariable Calculus</td>
</tr>
<tr>
<td>or MATH 291-2</td>
<td>MENU: Intensive Linear Algebra and Multivariable Calculus</td>
</tr>
</tbody>
</table>

or

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 240-0</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>or MATH 281-3</td>
<td>Accelerated Mathematics for ISP: First Year</td>
</tr>
<tr>
<td>or MATH 285-1</td>
<td>Accelerated Mathematics for MMSS: First Year</td>
</tr>
<tr>
<td>or MATH 290-1</td>
<td>MENU: Linear Algebra and Multivariable Calculus</td>
</tr>
<tr>
<td>or MATH 291-1</td>
<td>MENU: Intensive Linear Algebra and Multivariable Calculus</td>
</tr>
<tr>
<td>or GEN_ENG 205-1</td>
<td>Engineering Analysis I</td>
</tr>
</tbody>
</table>

1 computer science course:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_SCI 110-0</td>
<td>Introduction to Computer Programming</td>
</tr>
<tr>
<td>or COMP_SCI 111-0</td>
<td>Fundamentals of Computer Programming</td>
</tr>
</tbody>
</table>

2 courses chosen from approved Technical and Domain Science electives

1 approved Ethics elective course

1 See list of approved Technical and Domain Science courses below. For updates please refer to department website list of Technical and Domain Science Electives (https://statistics.northwestern.edu/undergraduate/data_science_major/technical-and-domain-science-electives.html).

2 See list of approved Ethics elective courses below. For updates please refer to department website list of Ethics electives (https://statistics.northwestern.edu/undergraduate/data_science_major/ethics-elective.html).

Technical and Domain Science Electives (students choose 2 courses; courses may be from different subject areas)

**Anthropology**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANTHRO 322-0</td>
<td>Introduction to Archaeology Research Design &amp; Methods</td>
</tr>
<tr>
<td>ANTHRO 324-0</td>
<td>Archaeological Survey Methods</td>
</tr>
<tr>
<td>ANTHRO 362-0</td>
<td>Advanced Methods in Quantitative Analysis</td>
</tr>
<tr>
<td>ANTHRO 389-0</td>
<td>Ethnographic Methods and Analysis</td>
</tr>
</tbody>
</table>

**Biological Sciences**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL_SCI 323-0</td>
<td>Bioinformatics: Sequence and Structure Analysis</td>
</tr>
<tr>
<td>BIOL_SCI 338-0</td>
<td>Modeling Biological Dynamics</td>
</tr>
<tr>
<td>BIOL_SCI 341-0</td>
<td>Population Genetics</td>
</tr>
<tr>
<td>BIOL_SCI 378-0</td>
<td>Functional Genomics</td>
</tr>
</tbody>
</table>

**Biomedical Engineering**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMD_ENG 311-0</td>
<td>Computational Genomics</td>
</tr>
</tbody>
</table>

**Chemical and Biological Engineering**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM_ENG 379-0</td>
<td>Computational Biology: Analysis and Design of Living Systems</td>
</tr>
</tbody>
</table>

**Communication**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMM_ST 352-0</td>
<td>Social Network Analysis</td>
</tr>
<tr>
<td>COMM_ST 371-0</td>
<td>Cultural Analytics</td>
</tr>
</tbody>
</table>

**Computer Science**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP_SCI 325-1</td>
<td>Artificial Intelligence Programming</td>
</tr>
<tr>
<td>COMP_SCI 336-0</td>
<td>Design &amp; Analysis of Algorithms</td>
</tr>
<tr>
<td>COMP_SCI 339-0</td>
<td>Introduction to Database Systems</td>
</tr>
<tr>
<td>COMP_SCI 348-0</td>
<td>Introduction to Artificial Intelligence</td>
</tr>
<tr>
<td>COMP_SCI 352-0</td>
<td>Machine Perception of Music &amp; Audio</td>
</tr>
</tbody>
</table>

**Earth and Planetary Science**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTH 323-0</td>
<td>Seismology and Earth Structure</td>
</tr>
<tr>
<td>EARTH 327-0</td>
<td>Geophysical Time Series Analysis</td>
</tr>
<tr>
<td>EARTH 340-0</td>
<td>Physics of Weather &amp; Climate</td>
</tr>
<tr>
<td>EARTH 343-0</td>
<td>Earth System Modeling</td>
</tr>
<tr>
<td>Course</td>
<td>Title</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>EARTH 353-0</td>
<td>Mathematical Inverse Methods in Earth and Environmental Sciences</td>
</tr>
<tr>
<td>EARTH 360-0</td>
<td>Instrumentation and Field Methods</td>
</tr>
<tr>
<td>EARTH 361-0</td>
<td>Scientific Programming in Python</td>
</tr>
<tr>
<td>EARTH 362-0</td>
<td>Data Analysis for Earth and Planetary Sciences</td>
</tr>
<tr>
<td>ECON 381-1</td>
<td>Econometrics</td>
</tr>
<tr>
<td>ECON 381-2</td>
<td>Econometrics</td>
</tr>
<tr>
<td>ECON 383-0</td>
<td>Applied Econometrics</td>
</tr>
<tr>
<td>ES_APPM 346-0</td>
<td>Modeling and Computation in Science &amp; Engineering</td>
</tr>
<tr>
<td>ES_APPM 370-1</td>
<td>Introduction to Computational Neuroscience</td>
</tr>
<tr>
<td>ES_APPM 375-1</td>
<td>Quantitative Biology I: Experiments, Data, Models, and Analysis</td>
</tr>
<tr>
<td>ES_APPM 375-2</td>
<td>Quantitative Biology II: Experiments, Data, Models, and Analysis</td>
</tr>
<tr>
<td>GBL_HLTH 320-0</td>
<td>Qualitative Research Methods in Global Health</td>
</tr>
<tr>
<td>IEMS 308-0</td>
<td>Data Science and Analytics</td>
</tr>
<tr>
<td>IEMS 313-0</td>
<td>Foundations of Optimization</td>
</tr>
<tr>
<td>IEMS 315-0</td>
<td>Stochastic Models</td>
</tr>
<tr>
<td>IEMS 317-0</td>
<td>Discrete Event Systems Simulation</td>
</tr>
<tr>
<td>IEMS 340-0</td>
<td>Qualitative Methods in Engineering Systems</td>
</tr>
<tr>
<td>IEMS 341-0</td>
<td>Social Networks Analysis</td>
</tr>
<tr>
<td>IEMS 351-0</td>
<td>Optimization Methods in Data Science</td>
</tr>
<tr>
<td>IMC 302-0</td>
<td>Research for Marketing Communications</td>
</tr>
<tr>
<td>IMC 307-0</td>
<td>Digital, Social and Mobile Marketing</td>
</tr>
<tr>
<td>JOUR 377-0</td>
<td>Knight Lab: Data Analysis &amp; Visualization</td>
</tr>
<tr>
<td>LING 334-0</td>
<td>Introduction to Computational Linguistics</td>
</tr>
<tr>
<td>MATH 306-0</td>
<td>Combinatorics &amp; Discrete Mathematics</td>
</tr>
<tr>
<td>MATH 308-0</td>
<td>Graph Theory</td>
</tr>
<tr>
<td>MATH 310-2</td>
<td>Probability and Stochastic Processes</td>
</tr>
<tr>
<td>MATH 310-3</td>
<td>Probability and Stochastic Processes</td>
</tr>
<tr>
<td>MATH 311-2</td>
<td>MENU: Probability and Stochastic Processes</td>
</tr>
<tr>
<td>MATH 311-3</td>
<td>MENU: Probability and Stochastic Processes</td>
</tr>
<tr>
<td>MATH 366-0</td>
<td>Mathematical Models in Finance</td>
</tr>
<tr>
<td>MATH 368-0</td>
<td>Introduction to Optimization</td>
</tr>
<tr>
<td>MATH 386-1</td>
<td>Econometrics for MMSS</td>
</tr>
<tr>
<td>MATH 386-2</td>
<td>Econometrics for MMSS</td>
</tr>
<tr>
<td>POLL_SCI 310-0</td>
<td>Methods of Political Inference</td>
</tr>
<tr>
<td>POLL_SCI 312-0</td>
<td>Statistical Research Methods</td>
</tr>
<tr>
<td>PSYCH 380-0</td>
<td>Advanced Statistics &amp; Experimental Design</td>
</tr>
<tr>
<td>PSYCH 387-0</td>
<td>Consumer Psychology and Marketing Research</td>
</tr>
<tr>
<td>SOCIOL 303-0</td>
<td>Analysis and Interpretation of Social Data</td>
</tr>
<tr>
<td>SOCIOL 329-0</td>
<td>Field Research and Methods of Data Collection</td>
</tr>
<tr>
<td>STAT 302-0</td>
<td>Data Visualization</td>
</tr>
<tr>
<td>STAT 320-3</td>
<td>Statistical Theory &amp; Methods 3</td>
</tr>
<tr>
<td>STAT 328-0</td>
<td>Causal Inference</td>
</tr>
<tr>
<td>STAT 342-0</td>
<td>Statistical Data Mining</td>
</tr>
<tr>
<td>STAT 344-0</td>
<td>Statistical Computing</td>
</tr>
<tr>
<td>STAT 348-0</td>
<td>Applied Multivariate Analysis</td>
</tr>
<tr>
<td>STAT 350-0</td>
<td>Regression Analysis</td>
</tr>
<tr>
<td>STAT 351-0</td>
<td>Design and Analysis of Experiments</td>
</tr>
<tr>
<td>STAT 352-0</td>
<td>Nonparametric Statistical Methods</td>
</tr>
<tr>
<td>STAT 353-0</td>
<td>Advanced Regression</td>
</tr>
<tr>
<td>STAT 354-0</td>
<td>Time Series Modeling and Forecasting</td>
</tr>
<tr>
<td>STAT 356-0</td>
<td>Hierarchical Linear Models</td>
</tr>
<tr>
<td>STAT 357-0</td>
<td>Introduction to Bayesian Statistics</td>
</tr>
<tr>
<td>STAT 365-0</td>
<td>Introduction to the Analysis of Financial Data</td>
</tr>
<tr>
<td>AF_AM_ST 215-0</td>
<td>Introduction to Black Social &amp; Political Life</td>
</tr>
<tr>
<td>AF_AM_ST 220-0</td>
<td>Civil Rights and Black Liberation</td>
</tr>
<tr>
<td>AF_AM_ST 319-0</td>
<td>Race, Ethnicity and the American Constitution</td>
</tr>
<tr>
<td>ENTREP 360-0</td>
<td>Leadership, Ethics, and You</td>
</tr>
<tr>
<td>GBL_HLTH 302-0</td>
<td>Global Bioethics</td>
</tr>
<tr>
<td>GBL_HLTH 324-0</td>
<td>Volunteerism and the Ethics of Help</td>
</tr>
<tr>
<td>HUM 325-5</td>
<td>Humanities in the Digital Age</td>
</tr>
<tr>
<td>IMC 310-0</td>
<td>Integrated Marketing and Communication Law, Policy and Ethics</td>
</tr>
<tr>
<td>IMC 311-0</td>
<td>Data Governance: Critical Issues in Digital Marketing Communications</td>
</tr>
</tbody>
</table>
The Data Science Major for Students in MMSS

Students majoring in both Data Science and MMSS will need to complete all requirements for the MMSS major and requirements for Data Science major are modified as follows (for triple major limitations see MMSS Adjunct Major [https://catalogs.northwestern.edu/undergraduate/arts-sciences/mathematical-methods-social-sciences/mmss-adjunct-major]):

- The introductory statistics course requirement (STAT 202-0, STAT 210-0, or equivalent) is waived
- STAT 228-0 is waived
- MATH 385-0 counts in place of STAT 320-1
- The 2 related Technical and Domain electives are automatically fulfilled by MATH 386-1 and MATH 386-2

All other data science major course requirements remain the same.

The Data Science Major for Students Majoring or Minoring in Statistics

For students who complete all requirements for Statistics major or minor, the requirements for the Data Science major are modified as follows:

- The introductory statistics course requirement (STAT 202-0, STAT 210-0, or equivalent) is waived.
- MATH 226-0 and MATH 230-2 are required in place of STAT 228-0.
- Statistics majors are NOT permitted to substitute STAT 228-0 or MATH 235-0, for MATH 226-0 and MATH 230-2.
- The 2 related Technical and Domain electives are automatically fulfilled by STAT 320-3 and STAT 350-0.
- STAT 320-1 and STAT 320-2 will be replaced with 2 elective courses approved by the Director of Data Science. These 2 elective courses may not be double-counted with any other Weinberg major or minor.

Note that there can be no double counting between the three 300 level elective courses required for the Statistics major and the required Data Science major courses including the elective courses designated as the STAT 320-1 and STAT 320-2 replacements.

All other Data Science major course requirements remain the same.

The Data Science Major for Students Majoring or Minoring in Weinberg Computer Science

For students who complete all requirements for the Weinberg Computer Science major or minor, the requirements for the Data Science major are modified as follows:

- STAT 304-0 will be replaced with 1 elective course approved by the Director of Data Science.

All other Data Science major course requirements remain the same.
Honors in Data Science

Majors with strong academic records and an interest in pursuing honors should contact the director of undergraduate studies no later than the start of senior year. Accepted students take 2 quarters of STAT 399-0 Independent Study, during which they develop and write a research paper; these enrollments do not count toward the major.

Students whose theses and grades meet department criteria are recommended to the college for graduation with honors. For more information consult the director of Data Science and see Honors in the Major (https://catalogs.northwestern.edu/undergraduate/arts-sciences/#academicoptionstext).