**DATA SCIENCE, MINOR**

Data Science applies core concepts in computer science, statistics and mathematics to problems in a wide variety of fields, from physical, social, biomedical, and behavioral sciences to arts and humanities. The minor targets students with strong analytical abilities and some existing programming experience, and requires courses in statistics, data-centric programming, data management, and data analysis. It also points to courses across the University that deal with data in areas of importance to Data Science.

**SEAS Second Major or Minor Option**

Students interested in a second major (College students only) or minor with SEAS are required to meet with the Undergraduate Curriculum Chair from the major/minor department you wish to declare to discuss requirements and obtain approval on the Second Major or Minor form. The approved form must be returned to the SEAS Research and Academic Services Office, 109 Towne Building.

For more information: [http://www.seas.upenn.edu/undergraduate/degrees/minors.php](http://www.seas.upenn.edu/undergraduate/degrees/minors.php)

### Data Science Minor

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Course Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Requirements</strong></td>
<td></td>
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<tr>
<td>CIS 120</td>
<td>Programming Languages and Techniques I</td>
<td>4</td>
</tr>
<tr>
<td>CIS 419/519</td>
<td>Applied Machine Learning ¹</td>
<td></td>
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<tr>
<td>or STAT 471</td>
<td>Modern Data Mining</td>
<td></td>
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<tr>
<td>or CIS 520</td>
<td>Machine Learning</td>
<td></td>
</tr>
<tr>
<td>NETS 212</td>
<td>Scalable and Cloud Computing</td>
<td></td>
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<tr>
<td>or CIS 545</td>
<td>Big Data Analytics</td>
<td></td>
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<tr>
<td>ENM 321</td>
<td>Engineering Statistics</td>
<td></td>
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<tr>
<td>or ESE 402</td>
<td>Statistics for Data Science</td>
<td></td>
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<tr>
<td>or STAT 431</td>
<td>Statistical Inference</td>
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<tr>
<td><strong>Data Science Electives</strong></td>
<td>2</td>
<td></td>
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<tr>
<td>Two electives required from two of the categories below. Approval required.</td>
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</tbody>
</table>

**Data-Centric Programming**

- CIS 105  Computational Data Exploration
- ENGR 105 Introduction to Scientific Computing
- OIDD 311 Business Computer Languages
- STAT 405 Statistical Computing with R (Cannot be taken by SEAS students)
- STAT 470 Data Analytics and Statistical Computing
- ESE 305 Foundations of Data Science

**Statistics**

- EAS 205
- CIS 261 Discrete Probability, Stochastic Processes, and Statistical Inference
- ESE 301 Engineering Probability
- BIOL 446 Statistics for Biologists
- STAT 430 Probability
- STAT 476 Applied Probability Models in Marketing

**Data Collection, Representation, Management and Retrieval**

- CIS 455/555 Internet and Web Systems
- CIS 450 Database and Information Systems
- or CIS 550 Database and Information Systems
- NETS 213 Crowdsourcing and Human Computation
- OIDD 105 Analytics in Excel VBA
- STAT 475 Sample Survey Design

**Data Analysis**

- CIS 419  Applied Machine Learning ²
- or CIS 519 Applied Machine Learning
- CIS 421 Artificial Intelligence
- CIS 520 Machine Learning
- MKTG 212 Data and Analysis for Marketing Decisions
- MKTG 309 Special Topics: Experiments for Business Decision Making
- OIDD 410 Decision Support Systems
- STAT 422 Predictive Analytics for Business
- STAT 435 Forecasting Methods for Management
- STAT 471 Modern Data Mining
- STAT 474 Modern Regression for the Social, Behavioral and Biological Sciences
- STAT 520 Applied Econometrics I

**Modeling**

- NETS 312 Theory of Networks
- MKTG 271 Models for Marketing Strategy
- OIDD 325 Computer Simulation Models
- OIDD 353 Mathematical Modeling and its Application in Finance
- STAT 433 Stochastic Processes
- STAT 436

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2021 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.

¹ Approval required.
² Both CIS 419/519 and CIS 520 cannot be taken for credit toward the minor.