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

Data Science Minor

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Course Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIS 120</td>
<td>Programming Languages and Techniques I</td>
<td>1</td>
</tr>
<tr>
<td>CIS 419</td>
<td>Applied Machine Learning</td>
<td>1</td>
</tr>
<tr>
<td>or STAT 471</td>
<td>Modern Data Mining</td>
<td></td>
</tr>
<tr>
<td>NETS 212</td>
<td>Scalable and Cloud Computing</td>
<td>1</td>
</tr>
<tr>
<td>ENM 321</td>
<td>Engineering Statistics</td>
<td>1</td>
</tr>
<tr>
<td>or ESE 302</td>
<td>Engineering Applications of Statistics</td>
<td></td>
</tr>
<tr>
<td>or STAT 431</td>
<td>Statistical Inference</td>
<td></td>
</tr>
</tbody>
</table>

Select two Data Science electives from two of the following required categories:

1 Approval required.

**Data-Centric Programming**

- CIS 110: Introduction to Computer Programming
- CIS 120: Programming Languages and Techniques I
- OIDD 311: Business Computer Languages
- ENGR 105: Introduction to Scientific Computing
- STAT 405: Statistical Computing with R
- STAT 470: Data Analytics and Statistical Computing

**Statistics**

- ESE 301: Engineering Probability
- ESE 302: Engineering Applications of Statistics
- ENM 321: Engineering Statistics
- STAT 430: Probability
- STAT 431: Statistical Inference
- STAT 471: Modern Data Mining
- STAT 476: Applied Probability Models in Marketing

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

- CIS 545: Big Data Analytics
- CIS 450: Database and Information Systems
- or CIS 550: Database and Information Systems
- NETS 212: Scalable and Cloud Computing
- NETS 213: Crowdsourcing and Human Computation

**Data Analysis**

- CIS 419 or CIS 519: Applied Machine Learning
- or CIS 520: Introduction to Machine Learning
- CIS 421: Machine Learning
- CIS 421: Artificial Intelligence
- CIS 421: Artificial Intelligence
- MKTG 212: 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: Introduction to Large-Scale Data Science

**Other Electives**

- CIS 106: Visualizing the Past.
- CIS 125: Technology and Policy

Total Course Units 6

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2018 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.