

# 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

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

Select two Data Science electives from two of the following required categories:<sup>1</sup>

### 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 or CIS 550	Database and Information Systems Database and Information Systems
NETS 212	Scalable and Cloud Computing
NETS 213	Crowdsourcing and Human Computation

OIDD 105	Developing Tools for Data Access and Analysis (VBA and SQL Programming)
STAT 475	Sample Survey Design
<i>Data Analysis</i>	
CIS 419 or CIS 519 or CIS 520	Applied Machine Learning Introduction to Machine Learning Machine Learning
CIS 421	Artificial Intelligence
CIS 421	Artificial Intelligence
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
<i>Modeling</i>	
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
<i>Other Electives</i>	
CIS 106	Visualizing the Past.
CIS 125	Technology and Policy
Total Course Units	6

<sup>1</sup> Approval required.

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.