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.

NOTE: This Catalog describes Weinberg College BA requirements that pertain to students who matriculated at Northwestern after spring quarter 2023. Refer to the Archives (https://catalogs.northwestern.edu/archives/) if you are following BA requirements described in the 2018-2019 through 2022-2023 editions.

Requirements for the Data Science Major

- Department Courses (p. 1) (11 units)
- Related Courses (may be double-counted with another major, or with a minor)
  - Related courses in mathematics (p. 1) (units vary). **MUST be taken EARLY in the program of study;** includes prerequisite courses for required department courses.
  - Related courses in technical and domain science electives (p. 2) (2 units)
  - Related ethics course (p. 3) (1 unit)

For details see course lists, below.

Department Courses

Course	Title
Department Courses (see course descriptions for prerequisites in mathematics)	
4 foundational courses:	
STAT 201-0	Introduction to Programming for Data Science [2]
or COMP_SCI 110-0	Introduction to Computer Programming
(students who do not take STAT 201-0 are responsible for independently learning content not covered in alternative course) [1]	
STAT 202-0	Introduction to Statistics and Data Science [2]
or STAT 210-0	Introduction to Probability and Statistics
or STAT 232-0	Applied Statistics
or approved introductory statistics course from another department [2]	
STAT 320-1	Statistical Theory & Methods 1 [2]
or STAT 383-0	Probability and Statistics for ISP
or MATH 310-1	Probability and Stochastic Processes
or MATH 311-1	MENU: Probability and Stochastic Processes
or MATH 314-0	Probability and Statistics for Econometrics
or MATH 385-0	Probability and Statistics for MMSS
or ELEC_ENG 302-0	Probabilistic Systems
or IEMS 302-0	Probability
(students who do not take STAT 320-1 are responsible for independently learning content not covered in alternative course) [1]	
STAT 320-2	Statistical Theory & Methods 2
6 data science core courses:	
STAT 301-1 & STAT 301-2 & STAT 301-3	Data Science 1 with R and Data Science 2 with R and Data Science 3 with R
or	
STAT 303-1 & STAT 303-2 & STAT 303-3	Data Science 1 with Python and Data Science 2 with Python and Data Science 3 with Python
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)	
STAT 304-0	Data Structures and Algorithms for Data Science [2]
or COMP_SCI 214-0	Data Structures & Algorithms
STAT 305-0	Information Management for Data Science [2]
or COMP_SCI 217-0	Data Management & Information Processing
STAT 362-0	Advanced Machine Learning for Data Science
1 capstone experience course:	
STAT 390-0	Data Science Project

1 Lists of topics not covered in substitute courses can be found on the department website (https://statistics.northwestern.edu/undergraduate/).

2 No more than 3 substitutions for STAT courses permitted

Related Course Requirement

Three types of related courses are required.

Related Courses - mathematics

Mathematics courses (units depend on mathematics sequence taken). **MUST be taken EARLY in the program of study**; includes prerequisite courses for required department courses.

Course	Title
See course descriptions for prerequisite sequencing of mathematics related courses	
MATH 220-1 & MATH 220-2	Single-Variable Differential Calculus and Single-Variable Integral Calculus
or MATH 218-1 & MATH 218-2 & MATH 218-3	Single-Variable Calculus with Precalculus and Single-Variable Calculus with Precalculus and Single-Variable Calculus with Precalculus
MATH 230-1	Multivariable Differential Calculus
or MATH 228-1	Multivariable Differential Calculus for Engineering
or MATH 281-1	Accelerated Mathematics for ISP. First Year
or MATH 285-2	Accelerated Mathematics for MMSS
or MATH 290-2	MENU: Linear Algebra and Multivariable Calculus
or MATH 291-2	MENU: Intensive Linear Algebra and Multivariable Calculus
or ES_APPM 252-1	Honors Calculus for Engineers
MATH 226-0 & MATH 230-2	Sequences and Series and Multivariable Integral Calculus
or STAT 228-0	Series and Multiple Integrals
or MATH 235-0	Series and Multiple Integrals
or MATH 226-0 & MATH 228-2	Sequences and Series and Multivariable Integral Calculus for Engineering
or MATH 226-0 & MATH 281-2	Sequences and Series and Accelerated Mathematics for ISP. First Year
or MATH 226-0 & MATH 285-3	Sequences and Series and Accelerated Mathematics for MMSS
or MATH 226-0 & MATH 290-3	Sequences and Series and MENU: Linear Algebra and Multivariable Calculus
or MATH 226-0 & MATH 291-3	Sequences and Series and MENU: Intensive Linear Algebra and Multivariable Calculus
or MATH 226-0 & ES_APPM 252-2	Sequences and Series and Honors Calculus for Engineers
MATH 240-0	Linear Algebra
or MATH 281-3	Accelerated Mathematics for ISP. First Year
or MATH 285-1	Accelerated Mathematics for MMSS

or MATH 290-1	MENU: Linear Algebra and Multivariable Calculus
or MATH 291-1	MENU: Intensive Linear Algebra and Multivariable Calculus
or GEN_ENG 205-1	Engineering Analysis I
or GEN_ENG 206-1	Honor Engineering Analysis

Related Courses - technical and domain science electives (students choose 2 courses; may be from different subject areas)

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). Some courses may have prerequisites; check course descriptions for details.

Anthropology

Course	Title
ANTHRO 322-0	Introduction to Archaeology Research Design & Methods
ANTHRO 324-0	Archaeological Survey Methods
ANTHRO 362-0	Advanced Methods in Quantitative Analysis
ANTHRO 389-0	Ethnographic Methods and Analysis

Biological Sciences

Course	Title
BIOL_SCI 323-0	Bioinformatics: Sequence and Structure Analysis
BIOL_SCI 338-0	Modeling Biological Dynamics
BIOL_SCI 341-0	Population Genetics
BIOL_SCI 378-0	Functional Genomics

Biomedical Engineering

Course	Title
BMD_ENG 311-0	Computational Genomics
BMD_ENG 312-0	Biomedical Applications in Machine Learning

Chemical Engineering

Course	Title
CHEM_ENG 379-0	Computational Biology: Analysis and Design of Living Systems
CHEM_ENG 367-0	Quantitative Methods in Life Cycle Analysis

Cognitive Science

Course	Title
COG_SCI 345-0	Presenting Ideas & Data

Communication Studies

Course	Title
COMM_ST 352-0	Social Network Analysis
COMM_ST 355-0	Audience Analysis
COMM_ST 358-0	Algorithms and Society
COMM_ST 371-0	Cultural Analytics

Computer Engineering

Course	Title
COMP_ENG 329-0	The Art of Multicore Concurrent Programming
COMP_ENG 358-0	Introduction to Parallel Computing
COMP_ENG 365-0	Internet-of-things Sensors, Systems, And Applications
COMP_ENG 368-0	Programming Massively Parallel Processors with CUDA

Computer Science

Course	Title
COMP_SCI 325-0	Artificial Intelligence Programming
COMP_SCI 331-0	Introduction to Computational Photography
COMP_SCI 333-0	Interactive Information Visualization
COMP_SCI 336-0	Design & Analysis of Algorithms
COMP_SCI 337-0	Natural Language Processing: Classical Approaches
COMP_SCI 339-0	Introduction to Database Systems
COMP_SCI 341-0	Social Networks Analysis
COMP_SCI 348-0	Introduction to Artificial Intelligence
COMP_SCI 352-0	Machine Perception of Music & Audio

Earth and Planetary Science

Course	Title
EARTH 323-0	Seismology and Earth Structure
EARTH 327-0	Geophysical Time Series Analysis
EARTH 340-0	Physics of Weather & Climate
EARTH 343-0	Earth System Modeling
EARTH 353-0	Mathematical Inverse Methods in Earth and Environmental Sciences
EARTH 360-0	Instrumentation and Field Methods
EARTH 361-0	Scientific Programming in Python

Economics

Course	Title
ECON 307-0	Economics of Medical Care
ECON 308-0	Money and Banking
ECON 316-0	Advanced Topics in Macroeconomics
ECON 325-0	Economic Growth & Development
ECON 326-0	The Economics of Developing Countries
ECON 327-0	Economic Development in Africa
ECON 336-0	Analytic Methods for Public Policy Analysis
ECON 337-0	Economics of State and Local Governments
ECON 339-0	Labor Economics
ECON 340-0	Economics of the Family
ECON 341-0	Economics of Education
ECON 342-0	Economics of Gender
ECON 349-0	Industrial Economics
ECON 350-0	Monopoly Competition & Public Policy
ECON 351-0	Law and Economics
ECON 354-0	Issues in Urban and Regional Economics
ECON 355-0	Transportation Economics and Public Policy
ECON 358-0	Economics of Art and Culture
ECON 359-0	Economics of Nonprofit Organizations
ECON 360-1	Foundations of Corporate Finance Theory
ECON 360-2	Investments
ECON 361-0	International Trade
ECON 362-0	International Finance
ECON 371-0	Economics of Energy
ECON 372-0	Environmental Economics
or ECON 373-0	Natural Resource Economics
ECON 381-1	Econometrics
ECON 381-2	Econometrics
ECON 383-0	Applied Econometrics

Electrical Engineering

Course	Title
ELEC_ENG 328-0	Information Theory & Learning
ELEC_ENG 331-0	Introduction to Computational Photography
ELEC_ENG 332-0	Introduction to Computer Vision
ELEC_ENG 335-0	Deep Learning Foundations from Scratch
ELEC_ENG 373-0	Deep Reinforcement Learning
ELEC_ENG 375-0	Machine Learning: Foundations, Applications, and Algorithms

Engineering Sciences and Applied Mathematics

Course	Title
ES_APPM 346-0	Modeling and Computation in Science & Engineering
ES_APPM 370-1	Introduction to Computational Neuroscience
ES_APPM 375-1	Quantitative Biology I: Experiments, Data, Models, and Analysis
ES_APPM 375-2	Quantitative Biology II: Experiments, Data, Models, and Analysis

Global Health

Course	Title
GBL_HLTH 303-0	(Re)mixing Qualitative Methods
GBL_HLTH 320-0	Qualitative Research Methods in Global Health

Industrial Engineering and Management Sciences

Course	Title
IEMS 308-0	Data Science and Analytics
IEMS 313-0	Foundations of Optimization
IEMS 315-0	Stochastic Models
IEMS 317-0	Discrete Event Systems Simulation
IEMS 340-0	Qualitative Methods in Engineering Systems
IEMS 341-0	Social Networks Analysis
IEMS 351-0	Optimization Methods in Data Science

Integrated Marketing and Journalism

Course	Title
IMC 302-0	Research and Data Analytics
IMC 307-0	Digital, Social and Mobile Marketing
JOUR 377-0	Introduction to Data Journalism
JOUR 342-2	Knight Lab: Artificial Intelligence in Media

Linguistics

Course	Title
LING 334-0	Introduction to Computational Linguistics

Mathematics

Course	Title
MATH 306-0	Combinatorics & Discrete Mathematics
MATH 308-0	Graph Theory
MATH 310-2	Probability and Stochastic Processes
MATH 310-3	Probability and Stochastic Processes
MATH 311-2	MENU: Probability and Stochastic Processes
MATH 311-3	MENU: Probability and Stochastic Processes
MATH 366-0	Mathematical Models in Finance
MATH 368-0	Introduction to Optimization
MATH 386-1	Econometrics for MMSS
MATH 386-2	Econometrics for MMSS

Music Theory

Course	Title
MUS_THRY 348-0	Corpus Studies

Political Science

Course	Title
POLI_SCI 310-0	Methods of Political Inference
POLI_SCI 312-0	Statistical Research Methods

Psychology

Course	Title
PSYCH 345-0	Presenting Ideas & Data
PSYCH 369-0	Psychological Tests & Measures
PSYCH 380-0	Advanced Statistics & Experimental Design
PSYCH 387-0	Consumer Psychology and Marketing Research

School of Education and Social Policy

Course	Title
SESP 272-0	Field Research Methods
SOC_POL 330-0	Economics of Social Policy
SOC_POL 331-0	Economics of Inequality and Discrimination
SOC_POL 333-0	Economics of Health, Human Capital, and Happiness

Sociology

Course	Title
SOCIOL 303-0	Analysis and Interpretation of Social Data
SOCIOL 329-0	Field Research and Methods of Data Collection

Statistics and Data Science

Course	Title
STAT 302-0	Data Visualization
STAT 320-3	Statistical Theory & Methods 3
STAT 328-0	Causal Inference
STAT 344-0	Statistical Computing
STAT 348-0	Applied Multivariate Analysis
STAT 350-0	Regression Analysis
STAT 351-0	Design and Analysis of Experiments
STAT 352-0	Nonparametric Statistical Methods
STAT 353-0	Advanced Regression
STAT 354-0	Time Series Modeling
STAT 356-0	Hierarchical Linear Models
STAT 357-0	Introduction to Bayesian Statistics
STAT 365-0	Introduction to the Analysis of Financial Data

Related Courses - ethics elective (students choose 1 course)

For updates please refer to department website list of Ethics Electives (https://statistics.northwestern.edu/undergraduate/data_science_major/ethics-elective.html). Some courses may have prerequisites; check course descriptions for details.

Black Studies

Course	Title
BLK_ST 215-0	Introduction to Black Social & Political Life
BLK_ST 220-0	Civil Rights and Black Liberation

Entrepreneurship

Course	Title
ENTREP 360-0	Leadership, Ethics, and You

Global Health

Course	Title
GBL_HLTH 302-0	Global Bioethics
GBL_HLTH 324-0	Volunteerism and the Ethics of Help

Humanities

Course	Title
HUM 325-5	Humanities in the Digital Age

Integrated Marketing and Journalism

Course	Title
IMC 310-0	IMC Law, Ethics and Technology
IMC 311-0	Data Governance
JOUR 303-0	Framed: Media and the Marginalized
JOUR 370-0	Media Law & Ethics

Latina and Latino Studies

Course	Title
LATINO 342-0	Latina and Latino Social Movements
LATINO 392-0	Topics in Latina and Latino Social and Political Issues

Performance Studies

Course	Title
PERF_ST 306-0	Performance and Race

Philosophy

Course	Title
PHIL 220-0	Introduction to Critical Theory
or COMP_LIT 207-0	Introduction to Critical Theory
PHIL 221-0	Gender, Politics, & Philosophy
or GNDR_ST 233-0	Gender, Politics, and Philosophy
PHIL 224-0	Philosophy, Race, and Racism
PHIL 240-0	Freedom and Responsibility
PHIL 262-0	Ethical Problems and Public Issues
PHIL 268-0	Ethics and the Environment
PHIL 269-0	Bioethics
PHIL 273-2	The Brady Scholars Program: The Good Life
PHIL 273-3	The Brady Scholars Program: The Good Society
PHIL 363-0	Kant's Moral Theory
PHIL 364-0	Business and Professional Ethics

Political Science

Course	Title
POLI_SCI 302-0	Subjects, Citizens, Revolutionaries: Early Modern Political Thought
POLI_SCI 303-0	Modernity and Its Discontents
POLI_SCI 304-0	Human Rights Between East and West
POLI_SCI 307-0	Deportation Law and Politics
POLI_SCI 309-0	Political Theories of the Rule of Law
or LEGAL_ST 309-0	Political Theories of the Rule of Law
POLI_SCI 347-0	Ethics in International Relations
POLI_SCI 382-0	Religion, Law, & Politics: Politics of Religious Diversity

Religious Studies

Course	Title
RELIGION 373-0	Religion and Bioethics

Slavic Languages and Literatures

Course	Title
SLAVIC 222-0	Language, Politics, & Identity
or LING 222-0	Language, Politics, and Identity
SLAVIC 260-0	Economics and the Humanities: Understanding Choice

Sociology

Course	Title
SOCIOL 220-0	Health, Biomedicine, Culture, and Society
or HUM 220-0	Health, Biomedicine, Culture, and Society
SOCIOL 321-0	Numbers, Identity & Modernity: How Calculation Shapes Who We Are & What We Know

Data Science Major with Additional Majors or Minors

The major in Data Science fulfills the Weinberg College requirement of completion of a major, but it also can be completed alongside another major, or with a minor. The general Weinberg College policies apply to such combinations. Below is clarifying text about how this works with certain combinations, and where particular exceptions to general rules are approved.

The Data Science Major for Students in the Integrated Science Program

Students complete all requirements for the ISP major, and the requirements for Data Science major are modified as follows:

- Introductory Statistics course requirement (STAT 202-0, STAT 210-0, STAT 232-0 or equivalent) is **waived**
- MATH 226-0 is **waived**
- STAT 383-0 Probability and Statistics for ISP counts in place of STAT 320-1
- The 2 related Technical and Domain electives are automatically fulfilled by MATH 381-0 Fourier Analysis and Boundary Value Problems for ISP and EARTH 350-0 Physics of the Earth for ISP

All other data science major course requirements remain the same.

The Data Science Major for Students in the Mathematical Methods in the Social Sciences Program

Students majoring in both Data Science and the adjunct major Mathematical Methods in the Social Sciences (MMSS) 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/)):

- Introductory Statistics course requirement (STAT 202-0, STAT 210-0, STAT 232-0 or equivalent) is **waived**
- MATH 226-0 is **waived**
- MATH 385-0 Probability and Statistics for MMSS counts in place of STAT 320-1
- The 2 related Technical and Domain electives are automatically fulfilled by MATH 386-1 Econometrics for MMSS and MATH 386-2 Econometrics for MMSS

All other data science major course requirements remain the same.

The Data Science Major for Students Majoring in Statistics

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

- Introductory Programming course requirement (STAT 201-0 or COMP_SCI 110-0 will be replaced with an additional 300-level STAT approved elective course. Statistics + Data Science majors take 3, 300-level STAT electives from the approved electives list for the Statistics major (see Statistics Major (https://catalogs.northwestern.edu/undergraduate/arts-sciences/statistics-data-science/statistics-major/)).
- Introductory Statistics course requirement (STAT 202-0, STAT 210-0, STAT 232-0, or equivalent) is **waived**
- The 2 related Technical and Domain electives are automatically fulfilled by STAT 320-3 Statistical Theory & Methods 3 and STAT 350-0 Regression Analysis
- STAT 320-1 and STAT 320-2 are replaced with 2 elective courses approved by the Director of Undergraduate Studies for Data Science. The 2 elective courses designated as the replacements may not be double counted with any other major/minor.

Note that there can be no double counting between the 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 Minoring in Statistics

Students complete all requirements for Statistics minor and requirements for Data Science major are modified as follows:

- Introductory Programming course requirement (STAT 201-0 or COMP_SCI 110-0) is replaced with a 300-level STAT elective course from the approved elective list for the Statistics major (see Statistics Major (https://catalogs.northwestern.edu/undergraduate/arts-sciences/statistics-data-science/statistics-major/)).
- Introductory Statistics course requirement (STAT 202-0, STAT 210-0, STAT 232-0, or equivalent) is **waived**
- The 2 related Technical and Domain electives are automatically fulfilled by STAT 320-3 Statistical Theory & Methods 3 and STAT 350-0 Regression Analysis
- STAT 320-1 and STAT 320-2 are replaced with 2 elective courses approved by the Director of Undergraduate Studies for Data Science. The 2 elective courses designated as the replacements may not be double counted with any other major/minor.

All other Data Science major course requirements remain the same.

The Data Science Major for Students Completing the Weinberg College Major or Minor in 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 Undergraduate Studies for Data Science.

All other Data Science major course requirements remain the same.

The Data Science Major for Students Majoring in IEMS or Computer Science (McCormick)

Students complete all requirements for their IEMS or Computer Science (McCormick) major. While none of the requirements for the Data Science major change it is important to note:

- Students are not permitted to use more than 3 courses from outside the Department of Statistics and Data Science to substitute for required Data Science major STAT courses. (see footnote 2)

Honors in Data Science

Majors with strong academic records and an interest in pursuing honors should contact the Director of Undergraduate Studies for Data Science 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 Undergraduate Studies for Data Science and see Honors in the Major (https://catalogs.northwestern.edu/undergraduate/arts-sciences/#academicoptionstext).