DATA ANALYTICS

Program Guidelines

Global connectivity and innovative technologies generate vast amounts of information that contribute to our understanding and evaluation of nature, human behavior, institutions, society, and beyond. This explosion of evidence to present and address problems is informing major decisions in academe, government, and the private sector. Those with an ability to work with quantitative and qualitative data, big and small, to identify puzzles, consider probing questions, evaluate claims, make inferences, and posit answers will be well positioned to expand knowledge, influence policy, and to be decision makers of the future.

The major in data analytics will provide you with a solid core of mathematics and computer science, followed by specially designed data analytics courses. All of these courses are project-based, employing analytic methods, as well as ethics and interdisciplinary research skills, practiced in a variety of application domains. In addition, you will take the skills learned in the classroom and practice them in a research experience or internship in a professional setting, and then pursue a capstone project informed by this experience.

Mission Statement

The Data Analytics Program prepares students to connect quantitative creative problem solving with the ability to disseminate results effectively and ethically. They learn how to acquire and handle various forms of data, to develop models that employ modern methods and algorithms to analyze and predict outcomes in data-rich environments that cover the myriad of disciplines in the liberal arts, and to communicate results through written, oral, and visual techniques to both professional and non-technical audiences. By engaging in active learning on interdisciplinary projects with an emphasis on problem solving, communication, and teamwork our students learn how to be good citizens in a rapidly changing, data-centric world. Our emphasis is on applying data analytics techniques to domain-specific data while recognizing the value of cultural knowledge and empathy that is best learned through broad exposure to the liberal arts.

Faculty

Director: Professor Daniel Homan (Physics & Astronomy)

Associate Professors: Anthony Bonifonte, Sarah Supp

Assistant Professors: Matthew Lavin, Alexandre Scarcioffolo, Mason Shero, Zhe Wang

Associate Director: Matthew Miller

Additional Committee Members: Anjali Fernandes (Earth and Environmental Science), Zarrina Juraqulova (Economics), Matt Kretchmar (Computer Science), Nestor Matthews (Psychology), Andrew C. McCall (Biology), Matthew Neal (Mathematics), Lindsey Schwartz (Philosophy)

Other Affiliated Faculty: Jessica Bean (Economics), Paul A. Djupe (Data for Political Research), Sangeet Kumar (Communication), Ashwin Lall (Computer Science), Nausica Marcos Miguel (Modern Languages), Adam Waterbury (Mathematics), David White (Mathematics), Lina Yoo (Biology)

Academic Administrative Assistant
Debbie Boissy

View faculty profiles and contact information (https://denison.edu/academics/data-analytics/contacts/)

Data Analytics Major

The major in Data Analytics (DA) requires a minimum of 46 credits of coursework and an approved summer experience. The detailed requirements are organized in three parts, as follows.

(a) First, students must complete the following 34 credits of core coursework:

Code	Title
DA 101	Introduction to Data Analytics
CS 109	Discovering Computer Science
or CS 111	Discovering Computer Science: Scientific Data and Dynamics
or CS 112	Discovering Computer Science: Markets, Polls, and Social Networks
MATH 135	Single Variable Calculus
or MATH 145	Multi-variable Calculus
DA 200	Data Analytics Colloquium (once as a sophomore and once as a junior or senior, 2 credits total)
DA 210/CS 181	Data Systems
DA/MATH 220	Applied Statistics
DA 301	Practicum in Data Analytics
DA 351	Advanced Descriptive Methods in Data Analytics
or DA 352	Advanced Predictive Methods in Data Analytics
or DA 353	Advanced Prescriptive Methods in Data Analytics
DA 401	Seminar in Data Analytics

(b) Second, students must complete a DA summer experience (internship or research project). This experience must be approved by the Data Analytics Program Committee, and is normally undertaken during the summer before the senior year.

(c) Third, students must acquire some depth in a domain of Data Analytics. They will then carry this disciplinary knowledge into their summer experience and senior seminar. Students may satisfy this requirement in one of two ways. First, they may choose to take the designated set of courses from one of the following departments.

Code	Title
Anthropology and Sociology (3 courses)	
Only students who matriculated prior to the Fall of 2023 may choose to graduate with an Anthropology/Sociology (ANSO) Data Analytics Concentration. The ANSO Data Analytics Concentration is not offered to students who matriculated Fall 2023 or thereafter.	
ANSO 100	People, Culture and Society
ANSO 343	Demography of Africa
OR any ANSO 300-level course pending approval by DA chair	
ANSO 351	Survey Research Methods
Biology (4 courses)	
BIOL 210	Molecular Biology and Unicellular Life
BIOL 220	Multicellular Life
BIOL 230	Ecology and Evolution
and one of the following:	
BIOL 345	Eukaryotic Cell Biology (Dr. Yoo only)

BIOL 350	Genomics
BIOL 356	Special Topics (Biostatistics)
Economics (4 courses)	
ECON 101	Introductory Macroeconomics
ECON 102	Introductory Microeconomics
ECON 302	Intermediate Microeconomic Analysis
ECON 467	Econometrics II (requires ECON 307 or DA 220/ MATH 220)
Earth and Environmental Sciences (4 courses)	
EESC 111	Planet Earth
Either	
EESC 234	Applied GIS for Earth and Environmental Sciences
Or	
EESC 222 & EESC 223	Geographic Information Systems I and Geographic Information Systems II
And one of the following:	
EESC 200	Environmental Geology
EESC 210	Historical Geology
EESC 211	Rocks, Minerals & Soils
And one of the following:	
EESC 300	Geomorphology
EESC 310	Global Biogeochemical Cycles
EESC 311	Structural Geology
EESC 313	Environmental Hydrology
EESC 314	Sedimentology & Stratigraphy
EESC 333	Stable Isotopes in the Environment
Sustainability & Environmental Studies (4 courses)	
SES 100	Introduction to Sustainability and Environmental Studies
SES 200	Environmental Analysis
And one of the following:	
SES 215	Renewable Energy Systems
EESC 234	Applied GIS for Earth and Environmental Sciences
SES 222 & SES 223	Geographic Information Systems I and Advanced GIS
SES 240	Environmental Politics and Decision-Making
SES 274	Ecosystem Management
And one of the following:	
SES 256	Farmscape: Visual Immersion in the Food System
SES 262	Environmental Dispute Resolution
SES 264	Environmental Planning and Design
SES 334	Sustainable Agriculture
Philosophy (3 courses)	
PHIL 121	Ethics: Philosophical Considerations of Morality
or PHIL 126	Social and Political Philosophy
PHIL 205	Logic
PHIL 210	Philosophy of Science
Physics (3 courses)	
Either:	
PHYS 121 & PHYS 122	General Physics I and General Physics II
Or	
PHYS 125 & PHYS 126 & PHYS 127	Physics I: Quarks to Cosmos and Physics II: Mechanics, Fluids, and Heat and Physics III: Electricity, Magnetism, Waves, and Optics
PHYS 312	Experimental Physics
Psychology (3 courses)	
PSYC 100	Introduction to Psychology
PSYC 200	Research Methods and Statistics
PSYC 2XX/3XX	Psychology elective (except research courses, 370, 410, 361-364, 451-452)

Alternatively, a student may submit an individualized 3-4 course domain elective plan, which must include at least one analytics-intensive course, to be considered for approval by the Data Analytics Program Committee. A successful one-page proposal will clearly describe the student's desired learning goals and how the proposed courses together achieve these goals. The proposal should also demonstrate the feasibility of completing the proposed courses in the time remaining before graduation. Proposals must be submitted prior to the end of the sophomore year.

Additional Points of Interest

Data Analytics majors wishing to study abroad should do so in the spring semester of their junior year. Data Analytics courses are not normally taken at other institutions, although on rare occasions, a suitable substitute may be found for DA 350 - Advanced Methods for Data Analytics.

If a student uses AP credit to skip a course in their chosen domain area, that course must be replaced with a suitable substitute, determined in cooperation with the appropriate department.

We recommend that students who wish to acquire deeper technical skills in data analytics and/or prepare for graduate work in data science, take additional courses in Mathematics and Computer Science. In Mathematics, students should begin by taking MATH 145 - Multi-variable Calculus and MATH 213 - Linear Algebra and Differential Equations. In Computer Science, students may take CS 173 - Intermediate Computer Science, CS 234 - Mathematical Foundations of Computer Science, and CS 271 - Data Structures. Beyond these, students may pursue additional advanced courses such as

Code	Title
CS 337/MATH 415	Operations Research
CS 339	Artificial Intelligence
CS 377	Database Systems
MATH 425	Applied Probability
MATH 435	Mathematical Modeling

Students may also pursue a minor or second major in Computer Science or Mathematics. Due to some course overlaps, these options require only 6-7 additional courses.

Courses

DA 101 - Introduction to Data Analytics (4 Credit Hours)
Many of the most pressing problems in the world can be addressed with data. We are awash in data and modern citizenship demands that we become literate in how to interpret data, what assumptions and processes are necessary to analyze data, as well as how we might participate in generating our own analyses and presentations of data. Consequently, data analytics is an emerging field with skills applicable to a wide variety of disciplines. This course introduces analysis, computation, and presentation concerns through the investigation of data driven puzzles in wide array of fields — political, economic, historical, social, biological, and others. No previous experience is required.

DA 199 - Introductory Topics in Data Analytics (1-4 Credit Hours)
A general category used only in the evaluation of transfer credit.

DA 200 - Data Analytics Colloquium (1 Credit Hour)
The Data Analytics colloquium involves three central learning components. 1) regular engagement with guest presentations and community activities in data analytics, 2) group discussion featuring critical analysis and connection of themes found in the guest presentations and in related data analytics topics, and 3) preparation and refinement of professional communication skills necessary for the required internship component of the data analytics major. This course provides an opportunity for students to connect on data analytics ideas and applications, using a range of perspectives that may or may not be normally encountered in a traditional course. Students will develop the knowledge, skills, and methods they need to progress to more advanced learning, while also creating bridges with members of the data analytics community within and outside of Denison. The course must be taken twice by majors: once as a sophomore, and again as either a junior or senior.
Prerequisite(s): DA 101 (may be taken concurrently).

DA 210 - Data Systems (4 Credit Hours)
This course provides a broad perspective on the access, structure, storage, and representation of data. It encompasses traditional database systems, but extends to other structured and unstructured repositories of data and their access/acquisition in a client-server model of Internet computing. Also developed are an understanding of data representations amenable to structured analysis, and the algorithms and techniques for transforming and restructuring data to allow such analysis.
Prerequisite(s): CS 109 or CS 110 or CS 111 or CS 112.
Crosslisting: CS 181.

DA 220 - Applied Statistics (4 Credit Hours)
Statistics is the science of reasoning from data. This course will introduce the fundamental concepts and methods of statistics using calculus-based probability. Topics include a basic study of probability models, sampling distributions, confidence intervals, hypothesis testing, categorical data analysis, ANOVA, multivariate regression analysis, logistic regression, and other statistical methods. Scopes of conclusion, model building and validation principles, and common methodological errors are stressed throughout.
Prerequisite(s): Either MATH 145 or both MATH 135 and DA 101.
Crosslisting: MATH 220.

DA 245 - Topics in Data Analytics (4 Credit Hours)
This course provides a venue to explore intermediate topics in Data. Topics courses will vary in content according to the interests of the faculty offering the course and possibly to introduce new classes into the curriculum. Courses at this level should be appropriate for students with introductory work in DA and/or related courses.

DA 271 - Theory and Practice of Data Visualization (4 Credit Hours)
Data visualization turns data and analysis into something people can see, and something they can comprehend. The practice of data visualization is built on the science of perception and the art of visual metaphors. While data visualization is a skillset demanded of any role involving data and analytics, there is also a field of study and discipline dedicated to the design and creation of graphical representations of data. This course introduces the discipline of data visualization, design principles and theory, and the way data visualization is used in a variety of fields. As part of this course, you will create and refine your own portfolio of dashboards and infographics, and learn to evaluate data visualization through workshops involving peer-to-peer feedback.
Prerequisite(s): DA 101.

DA 272 - Ethics of Data and Information (4 Credit Hours)
This course is a problem-driven, technically informed engagement with the ethics of data and information as well as an investigation of the moral dimensions of collecting, analyzing, and protecting data. It aims to equip students with the ethical frameworks and philosophical tools necessary to effectively engage with the urgent questions posed by data-driven technology in its various forms. Students will hone their understanding of the ethics of surveillance, scientific research, algorithmic bias, and policy decision-making. We will also investigate how familiar moral notions like privacy, property, fairness, and equality are challenged or illuminated by computational tools and the advent of novel possibilities for data collection and analysis. Projects in the course will seek to put into practice the ethical principles and moral theories in hopes of tackling data-driven decisions prudently and permissibly.

DA 281 - Analyzing Linguistic Data (4 Credit Hours)
This is a special topics course crosslisted with DH 281.

DA 286 - When AI Meets Feminism (4 Credit Hours)
This is a special topics course crosslisted with WGST 286.

DA 299 - Intermediate Topics in Data Analytics (1-4 Credit Hours)
A general category used only in the evaluation of transfer credit.

DA 301 - Practicum in Data Analytics (4 Credit Hours)
Utilizing Denison as a model of society, this practicum will explore questions of collective import through the analysis of new and existing sources of data. A problem-driven approach will lead to the acquisition of new, appropriate data analytic skills, set in an ethical context that carefully considers the implications of data display and policy recommendations on community members. A significant component of the course is working in teams to collect and analyze new data to address a puzzle or problem for a real client. Groups or organizations that serve as clients may come from the campus community, local non-profits, or businesses and groups across the region or country. The practicum also develops exposure to policymaking, implementing data driven insights, program management theory, interacting with leaders and professionals, and developing presentation skills appropriate for professional communication with the public. Though a significant learning opportunity itself, this course should also be seen as a prelude to a community internship or research experience in the post-junior year summer. Students should be aware that some off-campus travel may be necessary to meet with specific clients as necessary. Final presentations to the client, in lieu of a scheduled exam, requires flexibility and scheduling outside of the exam schedule.
Prerequisite(s): DA 101, DA 210 and DA 220, or consent of instructor.

DA 345 - Advanced Topics in Data Analytics (4 Credit Hours)
This course provides a venue to explore advanced topics in Data. Topics courses will vary in content according to the interests of the faculty offering the course and possibly to introduce new classes into the curriculum. Courses at this level should be appropriate for students with significant work in DA and/or related courses and may require other prerequisites.

DA 350 - Advanced Methods for Data Analytics (4 Credit Hours)
This course is designed to develop students' understanding of the cutting-edge methods and algorithms of data analytics and how they can be used to answer questions about real-world problems. These methods can learn from existing data to make and evaluate predictions. The course will examine both supervised and unsupervised methods and will include topics such as dimensionality reduction, machine learning techniques, handling missing data, and prescriptive analytics.
Prerequisite(s): DA 210 and DA 220 or consent of instructor.

DA 351 - Advanced Descriptive Methods in Data Analytics (4 Credit Hours)
Advanced Descriptive Methods (DA 351), in parallel with DA 352 and 353, is designed to develop students' understanding of the cutting-edge methods and algorithms of data analytics and how they can be used to answer questions about real-world problems. While all advanced methods for Data Analytics can be applied in a variety of capacities, descriptive analytics emphasizes using natural language processing (NLP) methods to work with text as data, modeling for interpretability, and designing and deploying computer vision systems. In DA 351 students will examine both supervised and unsupervised methods, including topics such as advanced regression, K nearest neighbors, hierarchical clustering, ranked cosine similarity, and deep learning.
Prerequisite(s): DA 210 or CS 181 and MATH 220 or DA 220 or MATH 242.

DA 352 - Advanced Predictive Methods in Data Analytics (4 Credit Hours)
Advanced Predictive Methods (DA 352), in parallel with DA 351 and 353, is designed to develop students' understanding of the cutting-edge methods and algorithms of data analytics and how they can be used to answer questions about real-world problems. While all advanced methods for Data Analytics can be applied in a variety of capacities, predictive methods emphasize learning from existing data to make predictions about new data. In DA 352 students will examine both supervised and unsupervised methods and will include topics such as clustering, classification, and network analysis.
Prerequisite(s): DA 210/CS 181; DA 220/MATH 220/MATH 242.

DA 353 - Advanced Prescriptive Methods in Data Analytics (4 Credit Hours)
Advanced Prescriptive Methods (DA 353), in parallel with DA 351 and 352, is designed to develop students' understanding of the cutting-edge methods and algorithms of data analytics and how they can be used to answer questions about real-world problems. While all advanced methods for Data Analytics can be applied in a variety of capacities, prescriptive analytics emphasizes formulating decision criteria, using data to identify optimal actions, and balancing benefits and tradeoffs of different solutions. In DA 353 students will examine both supervised and unsupervised methods and will include topics such as optimization and linear programming, reinforcement learning, simulation, and decision analysis.
Prerequisite(s): DA 210/CS 181; DA 220/MATH 220/MATH 242.

DA 361 - Directed Study (1-4 Credit Hours)

DA 362 - Directed Study (1-4 Credit Hours)

DA 363 - Independent Study (1-4 Credit Hours)

DA 364 - Independent Study (1-4 Credit Hours)

DA 399 - Advanced Topics in Data Analytics (1-4 Credit Hours)
A general category used only in the evaluation of transfer credit.

DA 401 - Seminar in Data Analytics (4 Credit Hours)
This is a capstone seminar for the Data Analytics major in which students work on independent research projects in a collaborative seminar setting. Problems may derive from internship experiences, courses of study at Denison, or another source subject to instructor approval. Heavy emphasis will be placed on providing ongoing research reports and collective problem solving and review.

DA 451 - Senior Research (4 Credit Hours)

DA 452 - Senior Research (4 Credit Hours)