DATA SCIENCE

The Master of Data Science (MDS) is a 12-month coursework program offered by the Department of Mathematics and Statistics that trains individuals to become computationally skilled and ethically minded data analysts. Students become well versed in key technologies in data science, including data wrangling, data mining, data integrity, visualization, machine learning, predictive modelling, and spatial-temporal methods. Through hands-on training, students analyze big data independently and collaboratively such that graduates are primed to help organizations translate data into knowledge and actionable insights. The program features in-class experiential learning opportunities, including how to address and describe complex problems relevant to industry partners, as well as how to explore ethical considerations of privacy, data security, objective analysis and visualization. Within the MDS program, students may choose to specialize in the field of Geospatial Analysis through additional technical training in Geographic Information System (GIS)/Remote Sensing (ie. geomatics).

Administrative Staff

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This list may include Regular Graduate Faculty, Associated Graduate Faculty and/or Graduate Faculty from other universities.

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MDS Program

Admission Requirements

Upon recommendation by the Department of Mathematics and Statistics, admission to the Master of Data Science may be granted to applicants who have completed an honour's Bachelor's degree or equivalent from an accredited institution with a minimum overall average of 75% (B) in the last four semesters of study with:

1) a major or minor in data science, computer science, mathematics, statistics, or a related field; **or**

2) working knowledge of statistics and computer programming, as demonstrated through completion of university or college level degree credit courses equivalent to the U of G courses STAT*3240 Applied Regression Analysis and CIS*2500 Intermediate Programming.

Please note: prospective students with an Honour's Bachelor's degree in an unrelated field who do not meet the above requirements may gain entry to the program after completing the Diploma in Applied Statistics (https://calendar.uoguelph.ca/undergraduate-calendar/programs-majors-minors/statistics-stat/#diplomatext) (or equivalent) with a minimum overall average of at least 75% (B).

Successful applicants must also meet the University of Guelph's English Proficiency requirements for admission. If an applicant's first language is not English, an English Language Proficiency test will be required during the application phase.

All complete applications will be received and reviewed by the Data Science Admissions Committee. The program especially encourages applications from qualified members of under-represented groups, particularly from those who self-identify as women, visible minorities and Indigenous peoples.

Learning Outcomes

Upon successful completion of the Master of Data Science program, graduates will have the capacity to:

1. Exhibit a solid understanding of statistics and competency in computer programming;
2. Demonstrate an in-depth understanding of the key technologies in data science: visualization, data mining, machine learning, and predictive modelling;
3. Develop advanced skills in data acquisition, processing, and manipulation;

4. Apply statistical methods and predictive modelling to answer queries, predict trends, and model real-world problems;
5. Analyze big data, including spatiotemporal data, using state-of-the-art software tools to draw meaningful conclusions;
6. Communicate and translate data into actionable insights for diverse audiences;
7. Create compelling narratives/presentations of data analysis results using appropriate data visualization and non-technical language;
8. Recognize, analyze and apply ethical practices in data science related to intellectual property, data security, integrity, and privacy throughout the full data life cycle, including collection, storage, processing, analysis, and deployment; and
9. Demonstrate foundational skills in GIS; students in the Geospatial Analysis field will demonstrate advanced skills in GIS and Remote Sensing technologies.

Program Requirements

All Master of Data Science students are required to complete a minimum of 4.00 graduate credits, as follows.

Students in the standard MDS program will complete the four core courses (2.00 credits), two courses from the MDS Restricted Electives list (1.00 credits), and two capstone courses (1.00 credit). Most MDS students will complete capstone courses DATA*6500 Analysis of Spatial-Temporal Data and DATA*6600 Applications of Data Science. With permission from the MDS Director, students may take DATA*6700 Data Science Project as an additional course, or as a substitute for one or two half-credit MDS Restricted Electives and/or capstone course DATA*6600 Applications of Data Science.

Geospatial Analysis Field

Students who choose to specialize in the field of Geospatial Analysis will complete the four core courses (2.00 credits), two courses from the Geospatial Analysis Restricted Electives list (1.00 credits), and DATA*6700 Data Science Project (1.00 credit). The project, to be completed in the Summer semester, must have an applied geomatics/environmental modelling focus, and must be approved by the MDS Director in advance.

Core Courses:

Code	Title	Credits
DATA*6100	Introduction to Data Science	0.50
DATA*6200	Data Manipulation and Visualization	0.50
DATA*6300	Analysis of Big Data	0.50
DATA*6400	Machine Learning for Sequential Data Processing	0.50

MDS Restricted Electives:

Code	Title	Credits
CIS*6020	Artificial Intelligence	0.50
CIS*6050	Neural Networks	0.50
CIS*6070	Discrete Optimization	0.50
CIS*6160	Multiagent Systems	0.50
CIS*6320	Image Processing Algorithms and Applications	0.50
ENGG*6070	Medical Imaging	0.50
ENGG*6100	Machine Vision	0.50
ENGG*6140	Optimization Techniques for Engineering	0.50
ENGG*6400	Mobile Devices Application Development	0.50
MATH*6020	Scientific Computing	0.50
MATH*6021	Optimization I	0.50
MATH*6022	Optimization II	0.50
MATH*6051	Mathematical Modelling	0.50
MATH*6071	Biomathematics	0.50
PHIL*6400	AI Ethics	0.50
PLNT*6500	Applied Bioinformatics	0.50
STAT*6550	Computational Statistics	0.50
STAT*6801	Statistical Learning	0.50
STAT*6802	Generalized Linear Models and Extensions	0.50
STAT*6721	Stochastic Modelling	0.50
STAT*6821	Multivariate Analysis	0.50
STAT*6841	Computational Statistical Inference	0.50
STAT*6950	Statistical Methods for the Life Sciences	0.50
GEOG*6420	Remote Sensing of the Environment	0.50
GEOG*6480	Advanced GIS and Spatial Analysis	0.50

Geospatial Analysis Restricted Electives:

Code	Title	Credits
GEOG*6480	Advanced GIS and Spatial Analysis	0.50
GEOG*6420 or GEOG*6550	Remote Sensing of the Environment Environmental Modelling	0.50

Capstone Courses:

Code	Title	Credits
DATA*6500	Analysis of Spatial-Temporal Data	0.50
DATA*6600	Applications of Data Science	0.50
DATA*6700	Data Science Project	1.00

Courses

DATA*6100 Introduction to Data Science Fall Only [0.50]
The course includes an introduction to the methods of modern statistics such as splines, general additive models, principal components analysis, and classifiers. Students learn resampling methods such as bootstrap, cross-validation, boosting, and bagging. Methods of model selection include search-and-score and regularization, and students practice communicating technical ideas to a non-technical audience, including via data visualization.
Restriction(s): Restricted to Master of Data Science students.
Department(s): Department of Mathematics and Statistics
Location(s): Guelph

DATA*6200 Data Manipulation and Visualization Fall Only [0.50]
This course provides a hands-on introduction to the manipulation and visualization of complex data sets using a programming language. Efficient techniques for importing and exporting data in various formats, data acquisition, data integrity, and good analysis practices are discussed. Several programming tools and libraries are introduced to restructure, transform and fuse disparate data types for visualization and data summaries in table format. Basics of manipulating space-time data is also covered.
Restriction(s): Restricted to Master of Data Science students.
Department(s): Department of Mathematics and Statistics
Location(s): Guelph

DATA*6300 Analysis of Big Data Unspecified [0.50]
This course introduces software tools and data science techniques for analyzing big data. It covers big data principles, state-of-the-art methodologies for large data management and analysis, and their applications to real-world problems. Modern and traditional machine learning techniques and data mining methods are discussed and ethical implications of big data analysis are examined. May be offered in conjunction with CIS*6180.
Restriction(s): Credit may be obtained for only one of CIS*6180 or DATA*6300. Restricted to Master of Data Science students
Department(s): School of Computer Science
Location(s): Guelph

DATA*6400 Machine Learning for Sequential Data Processing Unspecified [0.50]
This course emphasizes machine learning for sequential data processing. It covers common challenges and pre-processing techniques for sequential data such as text, biological sequences, and time series data. Students are exposed to machine learning techniques, including classical methods and more recent deep learning models, so that they obtain the background and skills needed to confront real-world applications of sequential data processing. May be offered in conjunction with CIS*6190.
Restriction(s): Credit may be obtained for only one of CIS*6190 or DATA*6400. Restricted to Master of Data Science students.
Department(s): School of Computer Science
Location(s): Guelph

DATA*6500 Analysis of Spatial-Temporal Data Summer Only [0.50]
This course introduces software tools and data science techniques for analyzing big geospatial data. An overview of raster-based geographic information systems (GIS) for identifying patterns and clusters in spatial-temporal data using state-of-the-art software and programming languages is provided. Concepts such as kriging/Gaussian processes, variograms and autoregressive correlation structures are discussed. Data summaries and visualizations specific to spatial-temporal problems are introduced.
Restriction(s): Restricted Master of Data Science students.
Department(s): Department of Mathematics and Statistics

DATA*6600 Applications of Data Science Summer Only [0.50]
This interdisciplinary team-taught seminar course provides students the opportunity to synthesize information, research methods, and present cutting-edge applications of data science. Learning outcomes include identifying reliable sources, understanding and presenting relevant contemporary data science methods, thinking critically about practical implementations of data science, and effective peer collaboration. Emphasis is placed on effectively communicating technical content and insights to a non-technical audience.
Prerequisite(s): DATA*6200 and DATA*6300
Restriction(s): Restricted to Master of Data Science students.
Department(s): Department of Mathematics and Statistics
Location(s): Guelph

DATA*6700 Data Science Project Unspecified [1.00]
This course is a one-semester research project course for students in the Master of Data Science program. In this course, students plan, develop, and write a faculty- or industry-led research paper, as well as present on their work. The project should advance knowledge or practice in data science or a closely related area, and address a real-world problem faced by industry. The project should focus on data science in the spatial and temporal dimension(s), to be approved by the course instructor.
Restriction(s): Instructor consent required.
Department(s): Department of Mathematics and Statistics
Location(s): Guelph