Master Programme DATA SCIENCE

Current as of October 1, 2020

Disclaimer: This is an unauthorized English summary of the curriculum. The official German version is the basis for all study matters and released by the Senate of the University of Vienna.

Overview

The goal of the Master programme Data Science is to provide a practically oriented and knowledge-based education in the field of modern data science. The task of Data Science is the development of efficient algorithms and a basic understanding of the interpretability and reliability of the results. This requires practical handling of large amounts of data, a solid mathematical and statistical foundation and familiarity in an application area. In addition, ethical and legal questions arise. The Master programme Data Science at the University of Vienna comprehensively reflects all these core competences, emphasises the interdisciplinary and heterogeneous character of Data Science and places it above a specialisation in individual fields. On the one hand, the foundation for a doctoral or PhD degree in mathematics, computer science, or statistics is laid. On the other hand, practical skills are acquired, such as handling huge amounts of data, the statistical analysis of complex data and the development, implementation, and analysis of efficient algorithms for data analysis.

The master programme Data Science is a 2-year, full-time programme with 120 ECTS credits. Admission to the Master's programme requires the completion of a relevant Bachelor's programme (Computer Science, Mathematics, Statistics, Business Informatics) or a relevant post-secondary Bachelor's programme (e. g. Fachhochschule) or another equivalent programme at a recognised Austrian or foreign post-secondary educational institution. The master programme Data Science is taught in English and requires English knowledge of level B2. Students are selected through an admission procedure. Graduates are awarded the academic degree "Master of Science" (MSc).

Curriculum Overview

(1) Compulsory module group CORE (30 ECTS)
   a. Compulsory module Introduction to Machine Learning 6 ECTS
   b. Compulsory module Statistics for Data Science 6 ECTS
   c. Compulsory module Mathematics of Data Science 4 ECTS
   d. Compulsory module Methods for Data Science 4 ECTS
   e. Compulsory module Mining Massive Data 6 ECTS
   f. Compulsory module Visual and Exploratory Analysis 4 ECTS
(2) Compulsory module group Doing Data Science, Ethical and Legal Issues (28 ECTS)
   a. Compulsory module Doing Data Science, Ethical and Legal Issues 12 ECTS
   b. Compulsory module Data Analysis Project and Seminar 16 ECTS
(3) Compulsory module Specialisation in Areas of Data Science (34 ECTS)
(4) Compulsory module Master Seminar (2 ECTS)
(5) Master's Thesis (24 ECTS)
(6) Master's Examination (2 ECTS)

Module Descriptions

(1) Compulsory module group CORE

IML Introduction to Machine Learning
Required pre-requisites: None
Recommended required pre-requisites: Basic knowledge of analysis and linear algebra, in probability theory and statistics as well as algorithmic thinking and programming language
Module goals: After completing the module, students will have knowledge of modern conceptual principles for solving various problems of machine learning, as well as their practical implementation.
Module structure: VU Introduction to Machine Learning (lecture with exercises), 6 ECTS credits, pi (continuous assessment)

SDS Statistics for Data Science
Required pre-requisites: None
Recommended required pre-requisites: Compulsory module Introduction to Machine Learning
Module goals: After completing the module, students are familiar with the following concepts and methods and can apply them independently in practice: Models and methods for special data structures (e.g. temporal or spatial information, waiting times, groups, images, or graphs), Models as approximations and as projections. Information vs. dimension (classical asymptotics and alternative approaches). Statistical learning with correctly specified models and under possible misspecification. Validation of estimators and predictors. Inference with estimators and predictors for model-based and model-free approaches.
Module structure: VU Statistics for Data Science (lecture with exercises), 6 ECTS credits, pi (continuous assessment)

MDS Mathematics of Data Science
Required pre-requisites: None
Recommended required pre-requisites: Basic knowledge of analysis, linear algebra and probability theory
Module goals: Upon completion of the module, students will have knowledge of various tools from linear algebra, harmonic analysis and probability theory to solve various problems in data processing and data analysis, such as dimensional reduction, collaborative filtering, image and signal processing, sparse regression, spectral graph theory, compressed sensing and topic modelling.
Module structure: VU Mathematics of Data Science (lecture with exercises), 4 ECTS credits, pi (continuous assessment)

OMD Optimisation Methods for Data Science
Required pre-requisites: None
Recommended required pre-requisites: Basic knowledge of analysis, linear algebra and probability theory
Module goals: Students acquire application-relevant knowledge in mathematical optimization that is useful in data science, e.g. mathematical modelling, duality theory, continuous (convex, non-convex, minimax) optimization including non-smooth models, discrete and mixed-integer optimization (including graph and network optimization), numerical methods for solving large scale optimization problems (including stochastic gradient methods), complexity, experiment design for method validation.
Module structure: VU Optimisation Methods for Data Science (lecture with exercises), 4 ECTS credits, pi (continuous assessment)

MMD Mining Massive Data
Required pre-requisites: None
Recommended required pre-requisites: Compulsory module Introduction to Machine Learning, compulsory module Mathematics of Data Science, compulsory module Statistics for Data Science
Module goals: After completing this module, students will know fundamental strategies for applying machine learning and data mining algorithms to very large amounts of data. Students are familiar with programming models for parallel and distributed data analysis, e.g. with MapReduce and Spark. They master techniques for efficient similarity searches, e.g. Locality Sensitive Hashing, as well as techniques for dimension reduction, classification and clustering of very large data sets. The participants have gained practical experience with these advanced methods and tools through exercises.
Module structure: VU Mining Massive Data (lecture with exercises), 6 ECTS credits, pi (continuous assessment)

VED Visual and Exploratory Data Analysis
Required pre-requisites: None
Recommended required pre-requisites: Compulsory module Introduction to Machine Learning
Module goals: In this module students learn the basics of visual data analysis and its application for explorative data analysis as well as better understanding and communication of data models. Principles of visual coding of data from different sources are taught. The students are able to analyse data or data models with tools such as Tableau or D3. They will also learn the iterative approach to building tools for visual data and model analysis and will implement this themselves using a concrete example. They will learn about perceptual and cognitive principles as well as special techniques in different application areas, such as finance, medicine, simulation, etc.
Module structure: VU Visual and Exploratory Data Analysis (lecture with exercises), 4 ECTS credits, pi (continuous assessment)

(2) Compulsory module group Doing Data Science, Ethical and Legal Issues

DEL Doing Data Science, Ethical and Legal Issues
Required pre-requisites: None
Recommended required pre-requisites: None
Module goals: In the course of an introductory project in heterogeneous teams, students acquire skills to successfully plan and solve application problems in the field of data science. Furthermore, students will learn about the ethical and legal challenges that arise when dealing with real data.
Module structure: VU Data Ethics and Legal Issues (lecture with exercises), 6 ECTS credits, 4 SSt (semester hour), pi (continuous assessment); VU Doing Data Science (lecture with exercises), 6 ECTS credits, pi (continuous assessment)

DAP Data Analysis Project and Seminar
Required pre-requisites: At least 24 ECTS credits from the modules in CORE
Recommended required pre-requisites: None
Module goals: In the course of a project, students acquire the ability to solve data science projects using the methods and techniques that the students have already learned during their studies. In the course of the seminar, students acquire the ability to research, analyse and prepare relevant knowledge-based questions in the field of data science as well as the ability to work in a knowledge-based way, as required for the master thesis.
Module structure: LP Data Analysis Project (practical laboratory course), 12 ECTS credits, 8 SSt (semester hour), pi (continuous assessment); SE Research Seminar (seminar), 4 ECTS credits, pi (continuous assessment)

(3) Compulsory module Specialisation in Areas of Data Science

SAD Specialisation in Areas of Data Science
Required pre-requisites: Modules in CORE
Recommended required pre-requisites: None
Module goals: Graduates are introduced to the state of the art of modern science in the field of the informatics and/or mathematical and/or statistical fundamentals of Data Science and acquire in-depth competence in concrete application areas, e.g. from human sciences, language processing, finance, medicine, physics or computational science.
Module structure: Depending on the courses offered, students choose courses total 34 ECTS from the following areas: Foundations, Applications. At least 12 ECTS must be completed in each of these areas. The courses eligible for this module are announced in the course catalogue. If other courses are chosen, these must be approved in advance by the Directorate of Studies.

(4) Compulsory module Master Seminar

MAS Master Seminar
Required pre-requisites: Modules in CORE, Doing Data Science, Ethical and Legal Issues, Specialisation in Areas of Data Science
Recommended required pre-requisites: None
Module goals: The students are able to write a master's thesis and present an intermediate state of the thesis.
Module structure: SE Master Seminar (seminar), 2 ECTS credits, pi (continuous assessment)

(5) Master's Thesis

The Master's thesis serves as proof of the ability to work on knowledge-related topics independently and in a way that is justifiable in terms of content and methodology. The topic of the Master's thesis can be taken from one of the compulsory or alternative compulsory modules. If a different subject is to be chosen or if there are uncertainties regarding the assignment of the chosen topic, a decision by the directorate of studies is required. The master's thesis is worth 24 ECTS credits.

(6) Master's Examination

The prerequisite for admission to the Master's examination is the positive completion of all prescribed modules and examinations and the positive assessment of the Master's thesis. The Master's examination is a public defence. It consists of the defence of the Master thesis and an examination of its scientific merit. The assessment is carried out according to the provisions of the statutes. The master's examination is worth 2 ECTS credits.

Recommended Schedule

Semester Plan Master Data Science