Curriculum for the master's programme in Data Science

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§ 1 Objectives and qualification profile

(1) **Qualification profile** The master's programme in Data Science at the University of Vienna aims at providing a practically oriented and scientifically sound education in the field of modern data science. Data science is an essential driving force in today's digital world. In almost all areas of today's economy, large amounts of data are collected and generated. Recently, data-driven methods have also gained a foothold in different parts of the natural sciences and humanities. The task of data science is to gain knowledge from ever bigger data volumes, which represents added value for the respective area. This requires not only the development of efficient algorithms, but also a basic understanding of the interpretability and reliability of results. A diverse and interdisciplinary competence profile is required, which particularly includes the practical handling of large amounts of data, a solid mathematical and statistical foundation as well as competences in the respective area of application. In addition, the rapid developments in data science raise ethical and legal questions. The master's programme in Data Science at the University of Vienna extensively reflects all these core competences and puts an emphasis on the interdisciplinary and heterogeneous character of data science, which is ensured by means of a specialisation in individual areas.

Therefore, the master's programme provides the foundation for a doctoral or PhD programme in the fields of mathematics, computer science, or statistics/OR, on the one hand. On the other hand, students acquire practical skills, such as the handling of huge amounts of data, the statistical analysis of complex data and the development, implementation and analysis of efficient algorithms for data analysis, which are in great demand on the labour market.

(2) **Learning outcomes:** The master's programme in Data Science provides students with a comprehensive basic academic education through the core modules, which, in particular, include foundations of algorithms, mathematics and statistics, the handling of large data volumes and exploratory data analysis. In addition, graduates are familiarised with ethical and legal aspects and gain practical experience in concrete application problems through the course Doing Data Science. In the elective modules, students are acquainted with the current state of research in the area of the computer science and/or mathematical and/or statistical foundations of data science. They acquire further competences in concrete fields of application, such as human sciences, language processing, finance, medicine, physics or computational science.

§ 2 Duration and scope

(1) The workload for the master's programme in Data Science comprises 120 ECTS credits. This is equivalent to a degree programme duration of four semesters.

(2) The programme is deemed completed if 94 ECTS credits as defined in the provisions on compulsory modules, 24 ECTS credits as defined in the provisions on the master's thesis and 2 ECTS credits as defined in the provisions on the master's examination have been obtained.

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pi (prüfungsimmanent): continuous assessment.
npi (nicht prüfungsimmanent): non-continuous assessment.
Course types and their abbreviations: see § 9.

§ 3 Entry requirements

(1) To be admitted to the master's programme in Data Science students must have completed an eligible bachelor's programme or an eligible degree programme at the same level of university education at a recognised Austrian or foreign post-secondary educational institution.

(2) The bachelor's programmes in Computer Science or Mathematics or Statistics or Business Informatics at the University of Vienna are certainly eligible.

(3) The master's programme is held in English. Therefore, students must have English language proficiency corresponding to level B2 (Common European Framework of Reference for Languages). For admission to the programme, applicants are selected in a selection procedure. Further regulations on the selection procedure will be specified in provisions by the Rectorate of the University of Vienna published in the University Gazette.

§ 4 Academic degree

Graduates of the master's programme in Data Science are awarded the degree "*Master of Science*", abbreviated as MSc. Where the academic degree is stated this must be after the name.

§ 5 Structure – Modules with allocated ECTS credits

(1) Overview

Group of compulsory modules: CORE Modules	**30 ECTS credits**
Compulsory module: Introduction to Machine Learning	6 ECTS credits
Compulsory module: Statistics for Data Science	6 ECTS credits
Compulsory module: Mathematics of Data Science	4 ECTS credits
Compulsory module: Optimisation Methods for Data Science	4 ECTS credits
Compulsory module: Mining Massive Data	6 ECTS credits
Compulsory module: Visual and Exploratory Data Analysis	4 ECTS credits
Group of compulsory modules: Doing Data Science, Ethical and Legal Issues	**28 ECTS credits**
Compulsory module: Doing Data Science, Ethical and Legal Issues	12 ECTS credits
Compulsory module: Data Analysis Project and Seminar	16 ECTS credits
Compulsory module: Specialisation in Areas of Data Science	**34 ECTS credits**
Compulsory module: Master's Seminar	**2 ECTS credits**
Master's Thesis	**24 ECTS credits**
Master's Examination	**2 ECTS credits**
TOTAL	**120 ECTS credits**

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(2) Module descriptions: Group of

compulsory modules: CORE

Modules

IML	Introduction to Machine Learning (compulsory module)	6 ECTS credits
Prerequisites	none	

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Course types and their abbreviations: see § 9.

Recommended prerequisite	Basic knowledge of analysis and linear algebra, probability theory and statistics as well as algorithmic thinking and a programming language
Module outcomes	Upon completion of the module, students have acquired knowledge of modern conceptual principles of solving various problems of machine learning, as well as their practical implementation.
Module structure	VU Introduction to Machine Learning, 6 ECTS credits, 4 SSt (pi)
Proof of performance	Passing of the continuous assessment course (pi) specified in the module (6 ECTS credits)

SDS	**Statistics for Data Science (compulsory module)**	**6 ECTS credits**
Prerequisites	none	
Recommended prerequisite	Compulsory module: Introduction to Machine Learning	
Module outcomes	Upon completion of this module, students are familiar with the following concepts and methods and are able to apply these independently in practice: Models and methods for special data structures (e.g. temporal or spatial information, waiting times, groups, images and graphs). Models as approximations and as projections. Information vs dimension (classical asymptotics and alternative approaches). Statistical learning by means of 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, 6 ECTS credits, 4 SSt (pi)	
Proof of performance	Passing of the continuous assessment course (pi) specified in the module (6 ECTS credits)	

MDS	**Mathematics of Data Science (compulsory module)**	**4 ECTS credits**
Prerequisites	none	
Recommended prerequisite	Basic knowledge of analysis, linear algebra and probability theory	
Module outcomes	Upon completion of the module, students have acquired knowledge of various tools from linear algebra, harmonic analysis and probability theory to solve various problems in the fields of 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, 4 ECTS credits, 3 SSt (pi)	
Proof of performance	Passing of the continuous assessment course (pi) specified in the module (4 ECTS credits)	

OMD	**Optimisation Methods for Data Science (compulsory module)**	**4 ECTS credits**
Prerequisites	none	
Recommended prerequisite	Basic knowledge of analysis, linear algebra and probability theory	

Module outcomes	Students acquire application-relevant knowledge of mathematical optimisation that is useful in data science, e.g. mathematical modelling, duality theory, continuous (convex, non-convex, minimax) optimisation, including non-smooth models, discrete and mixed-integer optimisation (including graph and network optimisation), numerical methods for solving large-scale optimisation problems (including stochastic gradient methods), complexity, experiment design for method validation.

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Module structure	VU Optimisation Methods for Data Science, 4 ECTS credits, 3 SSt (pi)
Proof of performance	Passing of the continuous assessment course (pi) specified in the module (4 ECTS credits)

MMD	Mining Massive Data (compulsory module)	6 ECTS credits
Prerequisites	none	
Recommended prerequisite	Compulsory module Introduction to Machine Learning, compulsory module Mathematics of Data Science, compulsory module Statistics for Data Science.	
Module outcomes	Upon completion of the module, students 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 are proficient in techniques for efficient similarity searches, e.g. Locality Sensitive Hashing, as well as techniques for dimension reduction, classification and clustering of very large volumes of data. The participants have gained practical experience with these advanced methods and tools through exercises.	
Module structure	VU Mining Massive Data, 6 ECTS credits, 4 SSt (pi)	
Proof of performance	Passing of the continuous assessment course (pi) specified in the module (6 ECTS credits)	

VED	Visual and Exploratory Data Analysis (compulsory module)	4 ECTS credits
Prerequisites	none	
Recommended prerequisite	Compulsory module: Introduction to Machine Learning	
Module outcomes	In this module, students learn the basics of visual data analysis and its application for exploratory data analysis as well as for a better understanding and communication of data models. Principles of visual coding of data from different sources are taught. Students are able to analyse data or data models with tools such as Tableau or D3. They also acquire the iterative approach to building tools for visual data and model analysis and implement this themselves using a concrete example. They 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, 4 ECTS credits, 3 SSt (pi)	
Proof of performance	Passing of the continuous assessment course (pi) specified in the module (4 ECTS credits)	

Group of compulsory modules: Doing Data Science, Ethical and Legal Issues

DEL	Doing Data Science, Ethical and Legal Issues (compulsory module)	12 ECTS credits
Prerequisites	none	

Recommended prerequisite	none
Module outcomes	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, 6 ECTS credits, 4
	SSt (pi) VU Doing Data Science, 6 ECTS credits, 4
	SSt (pi)
Proof of performance	Passing of all continuous assessment courses (pi) specified in the module (12 ECTS credits)

Compulsory module: Data Analysis Project

DAP	**Data Analysis Project and Seminar (compulsory module)**	**16 ECTS credits**
Prerequisites	At least 24 ECTS credits from the group of compulsory modules of CORE Modules	
Recommended prerequisite	none	
Module outcomes	In the course of a project, students acquire the skill to solve data science issues 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 academic questions in the field of data science as well as the ability to work in an academic way, as required for the master's thesis.	
Module structure	LP Data Analysis Project, 12 ECTS credits, 8 SSt (pi) SE Research Seminar, 4 ECTS credits, 3 SSt (pi)	
Proof of performance	Passing of all continuous assessment courses (pi) specified in the module (16 ECTS credits)	

Compulsory module: Specialisation in Areas of Data Science

SAD	**Specialisation in Areas of Data Science (compulsory module)**	**34 ECTS credits**
Prerequisites	none	
Recommended prerequisite	Group of compulsory modules: CORE Modules	
Module outcomes	Students are acquainted with the current state of research in the area of the computer science and/or mathematical and/or statistical foundations of data science. They acquire further competences in concrete fields of application, such as human sciences, language processing, finance, medicine, physics or computational science.	
Module structure	Subject to availability, students choose courses comprising 34 ECTS credits in total in the following areas: - Foundations - Applications At least 12 ECTS must be completed in each of these areas. The courses currently eligible for this module are listed in the course directory. If other courses are chosen, these must be approved in advance by the Directorate of Studies.	

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Proof of performance	Passing of all courses (npi) and continuous assessment courses (pi) specified in the module (34 ECTS credits in total)

Compulsory module: Master's Seminar

MAS	Master's Seminar (compulsory module)	2 ECTS credits
Prerequisites	Group of compulsory modules CORE, compulsory module Doing Data Science, Ethical and Legal Issues, compulsory module Data Analysis Project and Seminar	

Recommended prerequisite	none
Module outcomes	The students are able to write a master's thesis and present an intermediate state of the thesis.
Module structure	SE Master's Seminar, 2 ECTS credits, 1 SSt (pi)
Proof of performance	Passing of the continuous assessment course (pi) specified in the module (2 ECTS credits in total)

§ 6 Master's thesis

(1) The master's thesis serves to demonstrate the student's ability to achieve adequate standards of content and methodology when independently addressing academic topics. The assignment for the master's thesis must be chosen in a way that the student can reasonably be expected to complete it within six months.

(2) The topic of the master's thesis must be taken from one of the compulsory modules and/or alternative compulsory modules. If a different topic is selected or if there is uncertainty regarding allocation of the selected topic, the competent body responsible for study matters should decide on whether or not it is admissible.

(3) The master's thesis comprises 24 ECTS credits.

§ 7 Master's examination

(1) To be admitted to a master's examination the student must have successfully passed all required modules and examinations and the master's thesis must have been positively assessed.

(2) The master's examination is a public defence. This form of examination consists of a defence and an examination on the academic disciplines related to the master's thesis. Grading will be conducted as stipulated in the Statutes of the University of Vienna.

(3) The master's examination comprises 2 ECTS credits.

§ 8 Mobility during the master's programme

The competent body responsible for study matters is responsible for the recognition of academic achievements completed abroad.

§ 9 Course classification

(1) All courses with non-continuous assessment (npi) have to be offered as one of the following types of courses:

Lecture (*Vorlesung*, VO), non-continuous assessment (npi): Lectures serve to present contents, methods and applications of a specific subject. Contents are presented in the form of presentations delivered by the lecturer or in a similar form of presentation. The lecture is completed with an oral or written exam.

(2) All courses with continuous assessment (pi) are offered as one of the following types of courses:

Exercise (*Übung, UE*): Exercises should meet the practical and professional objectives of the degree

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programme and include concrete assignments.

Lecture with exercises (*Vorlesung mit integrierter Übung, VU*): A lecture with exercises combines the objectives of a lecture (VO) and exercise (UE).

Seminars (*Seminar, SE*): In seminars, continuous assessment is applied. Seminars serve as a setting for academic discussions. Participants are expected to independently work on a topic and present the insights gained in the form of independent oral or written contributions as presentations. Particular attention is paid to independent literature search and the development of an appealing lecture style.

Practical laboratory course (*Laborpraktikum, LP*): Practical laboratory courses should meet the practical and professional objectives of the degree programme and complement the professional prior education or academic education. These courses do not have to be tied to lectures. The students are assessed based on a project.

§ 10 Courses with a limited number of participants and registration procedures

(1) The following general limits on the number of students apply in the following courses with continuous assessment in this Curriculum:

25 participants

(2) For courses allocated to other degree programmes, the limits on the number of students specified in the relevant curricula apply.

(3) Modalities concerning the registration for courses and examinations as well as the allocation of places in courses are governed by the stipulations in the Statutes of the University of Vienna.

§ 11 Examination regulations

(1) Proof of performance in courses
The lecturer of a course is responsible for making the necessary announcements according to the stipulations in the Statutes.

(2) Examination content
The examination content relevant to preparing and holding examinations must be in line with the required number of ECTS credits. This also applies to module examinations.

(3) Examination procedure
The examination procedure is subject to the stipulations of the Statutes of the University of Vienna.

(4) No double recognition and no dual use
Courses taken and examinations passed in the three-year bachelor's programme, which constitute entry requirements for the master's programme, cannot be recognised again in the master's programme. Courses taken and examinations passed from another compulsory or elective module of the degree programme cannot be recognised within another module within the same degree programme. This also applies to recognition procedures.

(5) Examination results must be allocated to the relevant module by the stated ECTS figure and must not be allocated to different proofs of performance.

§ 12 Entry into force

(1) This Curriculum will enter into force upon announcement in the University Gazette of the University of Vienna as of 1 October 2020.

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(2) The amendments to the Curriculum as stated in the University Gazette of 27 June 2022, number 271, 45th edition enter into force on 1 October 2022.

§ 13 Transitional provisions

(1) This Curriculum applies to all students who commence their degree programme as of the winter semester of 2020.

(2) If, at a later stage of the degree programme, courses are no longer offered which were compulsory under the original curricula, the competent body responsible for study matters decides ex officio (equivalence regulation) or at the request of the student which courses and examinations have to be completed instead.

(3) The competent body responsible for study matters specified in the organisational regulations is entitled to determine in general or on a case-by-case basis which of the courses taken and examinations passed will be recognised for this Curriculum.

Appendix

Recommended path through the master's programme:

1st Semester (30)	Math of DS **4 CP** / Optimisation Methods **4 CP**	Introduction to Machine Learning **6 CP**	Statistics for DS **6 CP**	Specialisation **4 CP**	Doing Data Science **6 CP**
2nd Semester (30)	Mining Massive Data **6 CP**	Visual and Exploratory Data Analysis **4 CP**	Specialisation **6 CP**	Specialisation **8 CP**	Data Ethics and Legal Issues **6 CP**
3rd Semester (32)	Specialisation **8 CP**	Specialisation **8 CP**	Research Seminar **4 CP**	Data Analysis Project **12 CP**	
4th Semester (28)	Master's Thesis, master's thesis, master's seminar, public defence **(24+2+2) 28 CP**				

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