Master of Science (M.Sc.)

„Mannheim Master in Data Science“

University of Mannheim

– Module catalog –

Appendix

for students starting in or after autumn 2024

Academic Year

HWS 24/25

Die folgenden Veranstaltungen wurden nach Veröffentlichung des Modulkatalogs dem Kursprogramm hinzugefügt.

C. Data Management

Module no.	Name of Module	Offered	Language	ECTS	Page
IE 650	Knowledge Graphs	HWS	E	6	3

D. Data Analytics Methods

Module no.	Name of Module	Offered	Language	ECTS	Page
IE 695	Reinforcement Learning	HWS	E	6	6
DS 204	Mathematical Foundations of Machine Learning for Social data Scientists	FSS	E	6	

G. Projects and Seminars

Module no.	Name of Module	Offered	Language	ECTS	Page
MAS 515	Seminar Mathematische Optimierung	unregelmäßig	D	4	10

Detailed Descriptions

C. Data Management

IE 650	**Knowledge Graphs**
Form of module	Lecture
Type of module	Specialization course
Level	Master
ECTS	6
Workload	Hours per semester present at university: 56 h (4 SWS)
	Self-study: 124 h per semester • 82 h: pre and post lecture studying and revision • 42 h: examination preparation
Prerequisites	Java or Python programming skills
Aim of module	• The Role of knowledge graphs in the AI landscape • Semantic Web and its representation languages • Labeled property graphs • Query languages for knowledge graphs • Knowledge modeling and ontologies • Logical reasoning with knowledge graphs

	• Machine learning with knowledge graphs and knowledge graph embeddings
Learning outcomes and qualification goals	Expertise: The participants of this course learn about principles and applications of knowledge graphs. They become familiar with their technical foundations such as representation and query languages, or logical inference. After taking this course, the students will be aware of the problems and benefits of knowledge graph technologies in the context of tasks such as knowledge management, information search and data integration, and they will be capable of judging the applicability of these technologies for addressing practical challenges. (MK1, MK2)
	Methodological competence: The participants learn how to design and implement AI systems based on knowledge graphs. They are able to use standardized modeling languages for building knowledge representations, and to query these models by means of languages such as SPARQL. (MF3)
	Personal competence: By jointly building a knowledge graph-based application, the students learn how to effectively work in teams. They improve upon their presentation skills by showing the outcomes of their projects to the other participants of the course. (MKO1, MKO3)
Media	Lecture slides and exercise sheets will be available online
Literature	• Pascal Hitzler, Markus Krötzsch and Sebastian Rudolph, Foundations of Semantic Web Technologies, Chapman & Hall/CRC, 2009

	• Allemang and Hendler (2008): Semantic Web for the Working Ontologist. Verlag Morgan Kaufmann. • Antoniou and van Harmelen (2004): A Semantic Web Primer. MIT Press. • Fensel et al. (2020): Knowledge Graphs: Methodology, Tools and Selected Use Cases. Springer. • Kerjwal et al. (2021): Knowledge Graphs: Fundamentals, Techniques, and Applications. MIT Press.
Methods	The course participants will take part in theoretical and practical exercises, the solutions of which are discussed in the tutorials. At the end of the course, they get the opportunity to apply their knowledge in a team project. Each student team will design and implement a semantic web application, and subsequently present the results to the other students. Besides the exercises, regular presentations including references to relevant course materials and recommended readings will be given by the lecturer. The lecturer as well as the tutors offer individual help and consulting to the participants of the course.
Form of assessment	Written examination
Admission requirements for assessment	Project report and oral presentation
Duration of assessment	60 minutes
Language	English
Offering	Fall semester
Lecturer	Dr. Sven Hertling
Person in charge	Prof. Dr. Heiko Paulheim
Duration of module	1 semester
Further modules	-

Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, M.Sc Mannheim Master in Social Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

D. Data Analytics Methods

IE 695	**Reinforcement Learning**
Form of module	Lecture with Exercise (partially online)
Type of module	Data Analytics Methods
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4 SWS)
	Self-study: 98h (70h lectures/exercises, 28h exam preparation
Prerequisites	Machine Learning / Computer Vision /Generative Computer Vision Models course, theoretical and practical knowledge of neural networks
Aim of module	- Basic concepts of reinforcement learning: MDP, policies, on-policy, off-policy learning - Classical tabular reinforcement learning, DP, Policy Iteration, Q-Learning, SARSA, Monte-Carlo methods - Function approximation for reinforcement learning - Policy gradient methods

Learning outcomes and qualification goals	Expertise: After the course students will understand classical concepts of reinforcement learning as well as state of the art algorithms.
	Methodological competence: The students are able to understand and customize popular reinforcement learning algorithms, choose the right setting for their problem and train agents to perform well in environments with which they interact.
	Personal competence: The course trains abstract thinking and the ability to formally model application scenarios. By solving assigned exercises independently, the transfer of the learned material to related questions is promoted.
Media	Exercise sheets and lecture slides available online, blackboard
Literature	- Sutton & Barto: Reinforcement learning: an introduction, 2018
Methods	Lecture, exercises every two weeks, book studies
Form of assessment	Written or oral examination
Admission requirements for assessment	-
Duration of assessment	Written: 90 min. Oral: 25 min.
Language	English
Offering	HWS
Lecturer	Prof. Dr.-Ing. Margret Keuper

Person in charge	Prof. Dr.-Ing. Margret Keuper
Duration of module	1 Semester
Further modules	
Range of application	Msc Business Informatics, Msc Data Science, Lehramt Informatik
Semester	1./2./3. Semester

DS 204	**Mathematical Foundations of Machine Learning for Social Data Scientists**
Form of module	Lecture with Tutorial
Type of module	Data Analytics Methods
Level	Master
ECTS	6
Workload	In presence: 56 h (4 SWS)
	Exercises and self-study: 98 h
Prerequisites	This is an introductory course and has no pre-requisites. Data Science 100 or 200 is recommended.
Aim of module	The aim of the module is to equip students with the mathematics necessary to understand and work with machine learning models. This is an introductory course, pre-supposing only first year college level mathematics, at the level of basic algebra, calculus, and geometry. The module is aimed to get students from their current mathematical location to one where they can understand the basics of mathematics for machine learning, as well as allow them to study more advanced topics with a mathematical dimension. We will cover the material in the first seven chapters of Mathematics for Machine Learning, with a focus on depth of understanding rather than covering a broad range of topics.
Learning outcomes and qualification goals	Expertise: The student will gain proficiency in linear algebra, probability theory, and optimization.

	(MK1)
	Methodological Competence: The student will be able to combine the methods learned in the class with models encountered in applied questions and work in the social sciences. (MF2, MK3, MF5)
	Personal Competence: The student will learn basic proof structures and argument structures that can be used to strengthen their theses and professional arguments. (MK02)
Media	Slides will be prepared along with lecture notes; students will collaborate on a set of shared solutions.
Literature	**Mathematics for Machine Learning. (2020)**. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong. Cambridge University Press.
Methods	The course will involve a lecture where material is discussed as well as tutorial where material is practiced.
Form of assessment	Written Examination
Admission requirements for assessment	There will be assessments through the semester that will need to be passed in order to take the exam. These may include assessments in lecture or tutorial, as well as take home assignments.
Duration of assessment	90 minutes
Language	English
Offering	Spring Semester
Lecturer	Prof. Dr. Marc Ratkovic
Person in charge	Prof. Dr. Marc Ratkovic
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Mannheim Master in Data Science (PO 2024), M.Sc. Mannheim Master in Social Data Science
Semester	First/Second Semester

G. Projects and Seminars

MAS 515 (SEM 477)	**Fortgeschrittenenseminar Mathematische Optimierung**
Form der Veranstaltung	Seminar
Typ der Veranstaltung	Vertiefung
Modulniveau	Master
ECTS	4
Arbeitsaufwand	Präsenzstudium: 28 h pro Semester (2 SWS)
	Eigenstudium: • Vorbereitung des Vortrags: 62 h • Schriftliche Ausarbeitung des Vortrags: 30 h
Vorausgesetzte Kenntnisse	Numerik, Optimierung
Lehrinhalte	Ausgewählte Themen der Optimierung
Lern- und Kompetenzziele	Fachkompetenz: Vertiefte Kenntnisse in einem Spezialgebiet der Numerik / Optimierung (MK1, MK2, MF2)
	Methodenkompetenz: Fähigkeit, in einem Spezialgebiet einschlägige Fachliteratur lesen und präsentieren zu können (MF1, MO1, MO3, MO4)
	Personale Kompetenz: Kommunikationsfähigkeit (MO3, MO4)
Medienformen	Tafelanschriebe, Präsentationen mit Beamer
Begleitende Literatur	Ausgewählte Buchkapitel, Zeitschriftenartikel der Numerik / Optimierung / Stochastischen Optimierung
Lehr- und Lernmethoden	Vorträge der teilnehmenden Studierenden
Art der Prüfungsleistung	Vortrag und schriftliche Ausarbeitung
Prüfungsvorleistung	-
Prüfungsdauer	-
Sprache	Deutsch, auf Wunsch Englisch
Lehrende/r	Prof. Dr. Mathias Staudigl, Prof. Dr. Simon Weißmann

Modulverantwortlicher	Prof. Dr. Mathias Staudigl, Prof. Dr. Simon Weißmann
Dauer des Moduls	1 Semester
Weiterführende Module	
Verwendbarkeit	M.Sc. Wirtschaftsmathematik, M.Sc. Mathematik, M.Sc. Mannheim Master in Data Science
Einordnung in Fachsemester	Ab dem 1. Fachsemester