

Master of Science (M.Sc.)
„Mannheim Master in Data Science“

University of Mannheim

– Module catalog –

Appendix

Academic Year

HWS 22/23

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

Overview

B. Fundamentals

Module No.	Name of Module	Offered	Language	ECTS	Page
IS 557	Scientific Programming with Python**	Fall	E	6	MMM*

* For a detailed description, please see the module catalog of the respective following degree programs:

- MMM: M.Sc. Mannheim Master in Management, <https://www.bwl.uni-mannheim.de/studium/master/mmm/>

**Prerequisites: No completed exam in CS 470 Programming with Python

C. Data Management

Module No.	Name of Module	Offered	Language	ECTS	Page
CS 664	Blockchain Security	Fall	E	6	3
CS 664	Computer Graphics	Spring	E	6	5

D. Data Analytics Methods

Module No.	Name of Module	Offered	Language	ECTS	Page
CS 667	Computer Vision	Fall	E	6	7

IE 695	Reinforcement Learning**	Spring	E	6	8
MAB 519	Reinforcement Learning**	Spring	E	9	M.Sc. Wima und M.Sc. Mathematik*

*For a detailed description, please see the module catalog of the respective following degree programs:

M.Sc. Wima and M.Sc. Mathematik: <https://www.wim.uni-mannheim.de/studium/studienorganisation/m-sc-wirtschaftsmathematik/#c109976>

****Prerequisites: Students are allowed to be examined in only one of these two modules.**

E. Responsible Data Science

Module No.	Name of Module	Offered	Language	ECTS	Seite
AC 654	Additional Course – Responsible Data Science	Fall/Spring	E	Max 18	10

F. Project and Seminars

Module No.	Name of Module	Offered	Language	ECTS	Seite
CS 722	Seminar Ethical Aspects of AI	Spring	E	4	11

Detailed Descriptions

C. Data Management

CS 664	Blockchain Security
Form of module	Inverted classroom with exercises
Type of module	Specialization course
ECTS	6
Workload	Hours per semester present: 56h (4 SWS), Self-study: 112h
Prerequisites	There are no formal prerequisites but knowledge in cryptography and/or IT-security is recommended, e.g., by attending the lectures “Kryptographie I” or “Selected Topics in IT-Security”
Aim of module	Blockchains promise secure and reliable data storage and consensus in a trustless environment. In the light of their growing popularity, Blockchain security becomes increasingly important. The course will equip students with a solid understanding of blockchains, their design principles, underlying technologies and cryptographic primitives. Bitcoin, Monero and Ethereum will be discussed in greater detail and a substantial part of the course will be devoted to security issues and possible attacks.
Learning outcomes and qualification goals	<p>Expertise: Students will acquire profound knowledge of Blockchain technology as well as the skills to critically examine the security of Blockchain-based systems.</p> <p>Methodological competence: Successful participants will be able to understand and evaluate the different ways in which different Blockchain systems try to achieve security. They will also be able to identify where, why and how these security measures are broken for both, current and new systems.</p> <p>Personal competence: The analytic, concentrated, and precise thinking of the students is trained. As multiple different but related Blockchains are discussed, their abstraction capacity is further developed and the transfer of the learned concepts to related questions is trained.</p>
Media	Video recordings, annotated lecture slides
Literature	Will be announced in the lecture
Methods	Reworking the lecture and studying the relevant literature in self-study. During the lecture: discussing questions and ideas and working together on concrete examples. Solving exercises in self-study and in practice in cooperation with fellow students.
Form of assessment	Written exam
Admission requirements for assessment	-
Duration of assessment	90 Minutes
Language	English
Offering	HWS
Lecturer	Prof. Dr. Frederik Armknecht
Person in charge	Prof. Dr. Frederik Armknecht

Duration of Module	1 Semester
Further Modules	-
Range of application	M.Sc. Mannheim Master in Data Science, M.Sc. Wirtschaftsinformatik Lehramt Informatik M.Sc. Mathematik M.Sc. Wirtschaftsmathematik
Semester	1st/2nd/3rd semester

CS 644	Computer Graphics
Form of module	Lecture with Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56h (4 SWS)
	Self-study: 112h
Prerequisites	-
Aim of module	<ul style="list-style-type: none"> • Introduction to C/C++ • Ray Tracing • Lighting, Materials & Texturing • Spectral Analysis & Sampling Theory • Texture Filtering and Distribution Ray Tracing • Human Vision System, Color & HDR Imaging • Splines • Subdivision Surfaces • Camera Transformation and Clipping • Rasterization • Graphics APIs • Shader Programming • Shadow Algorithms • Volume Rendering
Learning outcomes and qualification goals	Expertise: <ul style="list-style-type: none"> • Get acquainted with the aims of the module (MK1, MK2, MF1, MF3)
	Methodological competence: <ul style="list-style-type: none"> • Programming of graphics applications

	(MF1, MF2, MF3)
	Personal competence: <ul style="list-style-type: none"> • Learn how to cope with a larger software project • Teamwork skills (MK01, MK02)
Media	Lecture slides, exercise sheets, project assignments, software, software documentation
Literature	<ul style="list-style-type: none"> • Steve Marschner and Peter Shirley, <i>Fundamentals of Computer Graphics</i>, 5th Edition, AK Peters, 2021 • Tomas Akenine-Möller et al., <i>Real-time Rendering</i>, 4th Edition, Taylor & Francis Ltd, 2018 • Matt Pharr and Greg Humphreys, <i>Physically Based Rendering</i>, 3rd Edition, Morgan Kaufmann, 2016 • John Hughes et al., <i>Computer Graphics: Principles and Practice</i>, 3rd Edition, Addison-Wesley, 2013 • Andrew S. Glassner, <i>An Introduction to Ray Tracing</i>, 1st Edition, Morgan Kaufmann, 1989
Methods	<ul style="list-style-type: none"> • Lecture • Weekly Exercises/programming projects
Form of assessment	Written examination (90 minutes)
Admission requirements for assessment	>=50% points in homework assignments in groups of 2-3 students
Duration of assessment	90 minutes written exam
Language	English
Offering	HWS 22
Lecturer	Junior Professor Dr. Roland Leiða
Person in charge	Junior Professor Dr. Roland Leiða
Duration of module	1 semester
Further modules	-
Range of application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik

Semester	1st/2nd/3rd semester
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D. Data Analytics Methods

CS 667	Computer Vision
Form of module	Lecture with Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4SWS)
Prerequisites	Basis skills in linear algebra, basis knowledge in python, machine learning; no completed exam in Higher Level Computer Vision (CS 646)
Aim of module	<ul style="list-style-type: none"> - CNNs, generative models and RNNs for computer vision - Detection, segmentation etc. - Self-supervised learning - Recent trends, e.g. transformers
Learning outcomes and qualification goals	<p>Expertise:</p> <p>The students have a detailed understanding of modern computer vision techniques based on machine learning. They can understand and evaluate given computer vision algorithms.</p>
	<p>Methodological competence:</p> <p>Students understand the technical basis of computer vision algorithms; they can explain the discussed methods and implement them.</p>

	Personal competence: Understanding complex Computer Vision problems; thorough judgment in the design and use of methods; can work efficiently in a team.
Media	Exercise sheets and lecture slides available online
Literature	- Computer Vision: Algorithms and Applications by Richard Szeliski - Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Orville
Methods	Lecture, weekly exercise, book studies, implementation of algorithms, visualization of results
Form of assessment	Written or oral examination (TBA)
Admission requirements for assessment	-
Duration of assessment	90 minutes (Written examination) or 15 minutes (Oral examination)
Language	English
Offering	Fall Semester
Lecturer	Juniorprofessor Dr. Paul Swoboda
Person in charge	Juniorprofessor Dr. Paul Swoboda
Duration of module	1 semester
Further modules	-
Range of application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st / 2nd / 3rd semester

IE 695	Reinforcement Learning
Form of module	Lecture with Exercise
Type of module	Specialization Course

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 course, theoretical and practical knowledge of neural networks
Aim of module	<ul style="list-style-type: none"> - 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	<p>Expertise: After the course students will understand classical concepts of reinforcement learning as well as state of the art algorithms.</p>
	<p>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.</p>
	<p>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.</p>
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 exam resp. Oral exam with smaller course size.
Admission requirements for assessment	-
Duration of assessment	Written: 90 min. Oral: 30 min.

Language	English
Offering	FSS
Lecturer	Prof. Dr. Paul Swoboda
Person in charge	Prof. Dr. Paul Swoboda
Duration of module	1 Semester
Further modules	
Range of application	Msc Business Informatics, Msc Data Science, Lehramt Informatik
Semester	1./2./3. Semester

E. Responsible Data Science

AC 654	Additional Course – Responsible Data Science
Form of module	Depends on course
Level	Master
ECTS	Max. 18
Workload	Depends on course
Prerequisites	Depends on course
Aim of module	The course falls into the responsible data science area of the MMDS and covers topics related to responsible data science, but is not directly equivalent to any course in the MMDS module catalogue. The course level equals a regular course in MMDS study program. The module can be taken either at the University of Mannheim or at any other university in Germany or abroad.
Learning outcomes and qualification goals	Depends on course

Media / Literature / Methods / Form and duration of assessment	Depends on course
Language	English preferred, but any other language possible if Mannheim faculty member is able to identify content and level
Offering	Spring semester / Fall semester
Lecturer	Lecturer at the host university
Person in charge	Lecturer at the host university
Duration of module	1 Semester
Further modules	-
Range of application	MMDS
Semester	2 nd /3 rd /4 th semester

F. Projects and Seminars

CS 722	Seminar Ethical Aspects of AI
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	IE 661 / IS 661 "Text Analytics" or IE 675b "Machine Learning" or IE 678 "Deep Learning" or IE 560 "Decision Support"
Aim of module	In this seminar, students perform scientific research, either in the form of a literature review or by conducting a small experiment, or a mixture of both, and prepare a written report about the results. Topics of interest focus around a

	variety of problems and tasks from the fields of Data-Science, Network Science and Text Mining.
Learning Outcomes and Qualification Goals	<p>Expertise:</p> <p>Students will acquire a deep understanding of the research topic. He/she is expected to describe in-depth and summarize the topic in detail in his/her own words, as well as to judge the contribution of the research papers to ongoing research.</p>
	<p>Methodological competence:</p> <p>Students will develop methods and skills to find relevant literature for his/her topic, to prepare methodologically sound scientific experiments, and to write a well-structured scientific paper and to present his/her results. He/she will be also aware of the need to avoid plagiarism. The key qualification Scientific Research is highly recommended as a prerequisite for the seminar.</p>
	<p>Personal qualification:</p> <p>Students will acquire skills on how to find relevant literature for a research topic, organize a small research task, write a well-structured, concise paper about it and present the results of their work. He/she is well prepared to write and present a Master's Thesis.</p>
Media	Scientific papers and books; presentation with PowerPoint or LaTeX.
Literature	Up-to-date literature will be assigned during the seminar.
Teaching and Learning Methods	Review scientific work independently under the guidance of a professor or a research staff member. Active discussions in a group of peers.
Form of Assessment	Written report with oral presentation
Admission requirements for assessment	-
Duration of Assessment	N/A
Language	English

Offering	Spring Semester
Lecturers	Markus Strohmaier, Simone Ponzetto
Person in charge	Markus Strohmaier, Simone Ponzetto
Duration of module	1 semester
Further modules	-
Range of Application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, M. Sc. Mannheim Master Management
Semester	3 rd semester