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 25/26

The following modules were added to the course program after the publication of the module catalogue.

1. Overview

D. Data Analytics Methods

Module no.	Name of Module	Offered	Language	ECTS
IE 685	Large Language Models and Agents (Lecture)	FSS	E	3
IE 692	Advanced Process Mining	FSS	E	6
IS 617*	Large Language Models for the Economic and Social Sciences	HWS	E	6
IS 618*	Social Media Data Analysis	FSS	E	6

*For a detailed description please use the module catalog of the „Mannheim Master in Management“: https://www.bwl.uni-mannheim.de/en/programs/master/mmm/module-catalogs-2011-2020/

F. Data Science Applications

Module no.	Name of Module	Offered	Language	ECTS
	Unwrapping the mind: knowledge, cognition, and AI	HWS	E	5
DS 601	AI product development	FSS	E	6

G. Projects and Seminars

Module no.	Name of Module	Offered	Language	ECTS
CS 730	Advanced Implementation Techniques for Database Systems	HWS	E	4
CS 733	Advanced Topics in Process Mining	irregular	E	4

CS 734	Green Software Engineering	FSS	E	4

2. Detailed descriptions

D. Data Analytics Methods

IE 685	Large Language Models and Agents
Form of module	Lecture
Type of module	Specialization course
Level	Master
ECTS	3
Workload	Hours per semester: 28 h (2 SWS) Self-study: 56 h per semester ● 31 h: pre and post lecture studying and revision ● 25 h: examination preparation
Prerequisites	● Machine learning concepts and techniques ● Knowledge about natural language processing
Aim of module	Large Language Models (LLMs) such as GPT, Llama, Gemini and Claude, have the potential to enable a wide range of new applications and to significantly improve the performance of existing systems. The course introduces students to LLMs as well as their application. The course covers the following topics: ● Introduction to LLMs ● Prompt engineering ● LLM-based agents ● Tool use and environment interaction ● Retrieval augmented generation ● Context engineering for LLM agents ● Safety and security of LLM agents ● Evaluation of LLM agents It is highly recommended to attend the course IE 686 Large Language Models and Agents Project in the same semester as this course as the schedules of both courses are aligned to each other.
Learning outcomes and qualification goals	Expertise: Students will be able to identify opportunities for employing Large Language Models in business applications and will learn to select and apply appropriate prompt/context engineering techniques for

	solving complex tasks. (MK1, MF1)
	Methodological competence: Participants will acquire knowledge on the application of Large Language Models and LLM agents for solving real-world problems. (MK2, MF3, MF4, MKO3)
	Personal competence: -
Media	Slide sets
Literature	● Zhao, et al.: A Survey of Large Language Models. arXiv:2303.18223v16, 2025. ● Wang, et al.: A Survey on Large Language Model based Autonomous Agents. Frontiers of Computer Science, 2024. ● Mohammadi, et al. Evaluation and benchmarking of LLM agents: A survey. SIGKDD Conference on Knowledge Discovery and Data Mining, 2025.
Methods	The course consists of a lecture that introduces students to Large Language Models and state of the art prompt/context engineering techniques.
Form of assessment	Written examination
Admission requirements for assessment	-
Duration of assessment	60 minutes
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Christian Bizer Dr. Ralph Peeters
Person in charge	Prof. Dr. Christian Bizer Dr. Ralph Peeters
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Mannheim Master in Data Science, Mannheim Master in Social Data Science, M.Sc. Wirtschaftsinformatik, Lehramt Informatik
Semester	2nd/3rd semester

IE 692	**Advanced Process Mining**
Form of Module	Lecture with exercise
Type of Module	Specialization course
Level	Master
ECTS	6
Workload	150 h per semester
Prerequisites	Familiarity with Petri nets and BPMN for process modeling, along with basic Python programming skills, is expected. Prior experience in process mining is not a prerequisite.
Aim of module	Process mining is a data-driven discipline that extracts qualitative and quantitative insights into the execution of organizational processes through the analysis of event data. It combines formal process models with data science and machine-learning techniques. The course covers the foundations, algorithms, and state-of-the-art methods of process mining, including: • Process discovery • Conformance checking • Process enhancement • Predictive monitoring • Non-traditional event data, including object-centric and partially ordered event data • Event data preprocessing, abstraction, and clustering Lectures are complemented by hands-on exercises that primarily focus on pen-and-paper problem solving, supported by selected implementations and evaluations using open-source process mining tools. A group project allows students to apply and evaluate process mining and ML-based methods in a practical setting.
Learning Outcomes and Qualification Goals	Knowledge: After completing the course, students will be familiar with both fundamental and state-of-the-art process mining techniques and algorithms for the data-driven analysis of business processes. (MK1, MK2)

	Capabilities: • After completing the course, students will be able to analyze business processes using process mining techniques and (open-source) process mining tools. (MF1, MF2, MF3)
	Competencies: • During the course, students will learn to apply, compare, and evaluate process mining techniques on synthetic and real-world data, both individually and in teams. (MKO1, MKO3)
Media	Electronic slides and exercise sheets
Literature	• van der Aalst: Process Mining: Data Science in Action, 2nd edition, Springer (2016) DOI: 10.1007/978-3-662-49851-4 • van der Aalst & Carmona (Editors): Process Mining Handbook, Springer (2022) DOI: 10.1007/978-3-031-08848-3 • Carmona et al.: Conformance Checking: Relating Processes and Models, Springer (2018) DOI: 10.1007/978-3-319-99414-7 • Additional academic papers will be recommended on a per-lecture basis.
Teaching and Learning Methods	• Lectures • Homework exercises to practice with joint discussion in exercise sessions
Form of assessment	80% written exam 20% group assignment
Admission requirements for assessment	-
Duration of assessment	The exam will take 90 minutes; the assignment will be spread over various weeks with a single deadline towards the end of the semester.
Language	English
Offering	Spring semester
Lecturers	Prof. Dr. Daniel Schuster
Person in charge	Prof. Dr. Daniel Schuster

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
Semester	2nd semester

F. Data Science Applications

	Unwrapping the mind: knowledge, cognition, and AI
Form of module	Lecture
Type of module	Elective
Level	Master
ECTS	5
Workload	Hours per semester present: 28 h (2 SWS)
	Self-study: 112 h per semester
Prerequisites	None
Aim of module	With the rise of AI models like GPT-4, machines seem capable of mimicking human cognitive processes—thinking, perceiving, learning, and even making decisions. Hence, the question what the core of "human cognition" actually is, has become a focus of interest. In this lecture series, experts in cognitive science will explore different questions, for example what makes human cognition exceptional (if at all), how AI challenges our understanding of intelligence, and what we might gain from integrating AI into cognitive research. We will also address how insights from human cognition can help develop more efficient, interpretable AI models and examine the ethical considerations that come with their use. The perspective of psychology will approach human cognition using both experiments and formal modeling. Lectures will tackle human judgment and decision making, memory processes and memory strategies developing across the life-span, categorization and estimation as well as metacognition - the knowledge about one's own cognitive processes. . From the linguistic perspective, we will focus on language acquisition and processing, as well as on the question how language relates to other domains of cognition. We will present both experimental results and historical corpus data to showcase how language is represented and processed in the

	mind and how learners acquire language along the dimension of time. From a computational and AI-driven standpoint, the series will cover the modeling of cognitive processes, investigating how human judgment and decision-making are represented in computational frameworks. We will also explore the inner workings of AI language models, discussing how they process and generate language and how they can be extended through multimodal learning and interaction with users. The philosophy lectures will explore what it means to say that something or someone "thinks" or "feels". We examine whether attributing mental states to artificial machines differs fundamentally from doing so to humans or non-human animals. We hope that this will also shed light on the broader implications of AI for our general understanding of mind and agency. Bringing together research from psychology, linguistics, computational science, and philosophy, this series offers a rich and interdisciplinary exploration of intelligence, learning, and perception—both human and artificial.
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge of current research on language and the mind at the crossroads of linguistics, natural language processing, psychology and philosophy. (MK1, MK2, MK3)
	Methodological competence: Students learn to understand and summarize the state of the art in a certain area and discuss achievements and open problems. (MF2, MKO2)
	Personal competence: -
Media	Slides, Research Papers
Literature	Recommended Papers from invited speakers
Methods	Lectures, independent study
Form of assessment	Written examination
Admission requirements for assessment	-
Duration of assessment	90 Minutes

Language	English
Offering	Fall semester
Lecturer	Prof. Dr. Arndt Bröder, Prof. Dr. Beatrice Kuhlmann, Prof. Dr. Carola Trips, Prof. Dr. Nicole Altvater-Mackensen, Prof. Dr. Simone Paolo Ponzetto, Prof. Dr. Wolfgang Freitag, Invited Speakers
Person in charge	Prof. Dr. Arndt Bröder, Prof. Dr. Beatrice Kuhlmann, Prof. Dr. Carola Trips, Prof. Dr. Nicole Altvater-Mackensen, Prof. Dr. Simone Paolo Ponzetto, Prof. Dr. Wolfgang Freitag
Duration of module	1 Semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, MMDS, MMSDS
Semester	2.-4.

DS 601	**AI product development**
Form of module	Lecture and Tutorial
Type of module	Foundations of AI product development
Level	Masters
ECTS	6 (180 hours)
Workload	*Hours per semester present: 56 h (4 SWS)*
	Presentations: 124 h per semester ● *40 h: Practicing class exercises* ● *84 h: Working on class group project*
Prerequisites	To excel in this course, students should have a solid foundation in data science, data analysis, and machine learning algorithms. A basic understanding of Large Language Models (LLMs) is essential. Working knowledge of advanced AI concepts like Retrieval-Augmented Generation (RAG), various prompting methods, and practical experience in developing prototypes with AI tools will be highly beneficial. Prior to admission, students must submit a one-page, single spaced statement of purpose. This will share their interest in this project, summarize relevant coursework and grades, experience, and ideas. Students can apply on one of two tracks: as software engineers or business entrepreneurs. Please state clearly which track is being selected and what academic program and degree you are currently pursuing. Groups will integrate members from each track, integrating product development with software design and implementation. A willingness to focus in one area but work and learn across both is essential. Details for the application submission will be on the website of Prof. Ratkovic's Chair.
Aim of module	The primary aim of this course is to equip students with the skills to transform their project ideas into viable business products, all while maintaining a steadfast focus on the core principles of responsible computing and explainable AI.

	Students will collaborate with organizations in technology, policy, and government, developing projects that advance key areas like journalism, fact-checking, digital literacy, and healthcare. The program provides continuous mentoring and access to vital resources and networks, enabling participants to move beyond traditional academic boundaries and engage in real-world product development.
Learning outcomes and qualification goals	(MK2) technology-oriented students learn the concepts, algorithms and strategies used to solve concrete, practical application-oriented problems in informatics.
	(MF4) independently tackle problems in data management and analytics and describe their results in a structured, written form.
	(MKO1) apply their knowledge and capabilities to solve specific problems in a team context.
	(MKO2) use their interdisciplinary education to mediate between technical and non-technical individuals.
	(MKO3) evaluate the latest changes in programming languages, systems, models and, wherever possible, exploit them to develop better solutions to data-science related problems.
Media	Lecture slides and exercises will be available online.
Literature	Since the course emphasizes practical applications and AI product development, project-specific literature will be provided during the sessions alongside the presentation slides.
Methods	Lecture elements, weekly product development updates
Form of assessment	Final product (report or dashboard; 70%); Preliminary oral or written reports (20%); Comments and feedback on other groups (10%)
Admission requirements for assessment	Homework, practical programming projects, or written and oral reports, in-class exams.
Duration of assessment	
Language	English
Offering	Spring semester
Lecturer	Dhara Mungra

Person in charge	Prof. Dr. Marc Ratkovic
Duration of module	1 semester
Further modules	
Range of application	MMSDS, MMDS, Mannheim Master in Management, CDSS
Semester	Second or fourth semester

H. Projects and Seminars

CS 730	**Advanced Implementation Techniques for Database Systems**
Form of module	Seminar
Type of module	Seminar
Level	Master
ECTS	4
Workload	120h per semester
Prerequisites	DBSI, DBSII, Query Optimization
Aim of module	The student prepares a scientific paper and gives a presentation on a current research topic based on published research. State-of-the-art topics are proposed by the professors. The paper and the presentation are prepared under the guidance of a professor or a research staff member. Active participation in the seminar discussions is expected.
Learning outcomes and qualification goals	<u>Expertise:</u> The student gains a deep understanding of the research topic. They are able to describe/summarize the topic in detail in their own words. They reflect on the topic and judges the contribution of the research paper.
	<u>Methodological competence:</u> The student is able to write a well-structured scientific paper and to present their results. They are also aware of the need to avoid plagiarism. The key qualification Scientific Research is highly recommended as a prerequisite for the seminar.
	<u>Personal qualification:</u> The student has learned how to write a well-structured, concise paper and give a presentation. This is part of the preparation to write and present a Master's Thesis.
Media	Slides, blackboard
Literature	To be announced in the seminar
Teaching and Learning Methods	Do scientific work independently under the guidance of a professor or a research staff member. Active discussions in a group of peers.
Form of assessment	Presentation (80%), Report (20%)
Admission requirements for assessment	-
Duration of assessment	Presentation (30min), Report (17pages)
Language	English

Offering	Irregular
Lecturer	Prof. Dr. Moerkotte
Person in charge	Prof. Dr. Moerkotte
Duration of module	1 Semester
Further modules	-
Range of application	Master Wirtschaftsinformatik; MMDS
Semester	2./3. Semester

CS 733	**Advanced Topics in Process Mining**
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Participants are expected to have fundamental knowledge of process mining, including basic concepts, techniques, and tools, to actively engage with the seminar content.
Aim of module	In this seminar, each student conducts scientific research on advanced topics in process mining, either as a literature review, a small experimental study, or a combination of both. Each student prepares a written report and delivers a presentation to the class, sharing their findings and insights with peers. Topics of interest include classical process mining tasks, such as process discovery, conformance checking, and predictive process monitoring, explored through current research trends and novel approaches, including generative AI, machine learning applications, and the analysis of non-traditional event data types. The seminar encourages students to investigate innovative methods, emerging challenges, and practical implications in the field.
Learning Outcomes and Qualification Goals	Expertise: Students will develop a deep understanding of the research topic. They are expected to critically analyze and comprehensively summarize the topic in their own words, as well as evaluate the contribution of the research papers to ongoing research in the field.
	Methodological competence: Students will develop the methods and skills needed to identify relevant literature for their topic, design methodologically sound scientific experiments, write a well-structured scientific paper, and effectively present their results. They will also gain awareness of the importance of academic integrity and the need to avoid plagiarism.

	Personal Qualification: Students will acquire the skills required to identify relevant literature for a research topic, organize and conduct a small-scale research project, write a well-structured and concise academic paper, and effectively present their results. They will be well prepared to write and present a Master's thesis.
Media	Scientific papers and books
Literature	• Depends on the specific topic • For a general overview of the field, the following book is recommended: Wil van der Aalst: *Process Mining: Data Science in Action*, 2nd edition
Teaching and Learning Methods	Perform scientific work independently under the guidance of a professor or a research staff member
Form of Assessment	• Seminar paper (50%) • Mid-term presentation (10%) • Final presentation (40%)
Admission requirements for assessment	–
Duration of Assessment	• Seminar paper: 18 pages (excluding appendix and references) • Mid-term presentation: 10 minutes presentation + 10 minutes discussion • Final presentation: 20 minutes presentation + 10 minutes discussion
Language	English
Offering	Irregular
Lecturers	Prof. Dr. Daniel Schuster
Person in charge	Prof. Dr. Daniel Schuster
Duration of module	1 semester
Further modules	–
Range of Application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	3rd semester

CS 734	**Green Software Engineering**
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	CS Fundamentals; Previous participation in the courses “Web Search and Information Retrieval” and “Text Analytics” are recommended.
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, prepare a written report about the results, peer review reports and present their own results. Topics of interest focus around a variety of problems and tasks from the fields of Green Software Engineering combined with Data-Science, and Text Mining.
Learning Outcomes and Qualification Goals	Expertise: 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, judge the contribution of the research papers and present them (MK1); (MK1, MK2, MK3)
	Methodological competence: 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. (MF1, MF2, MF3)
	Personal qualification: 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. (MKO1) MF2

Media	Slides, scientific papers, books, software and datasets
Literature	Depends on the sub-topic.
Teaching and Learning Methods	• Self-study of assigned material, presentation of scientific articles, joint discussion of work, collaboration with peers • Preparation of a seminar report (12 pages, plus bibliography • Presentation of the seminar paper and answering questions (15 minutes) • Participation in the presentation discussions • Reflection on a seminar report written by someone else
Form of Assessment	• Presentation and discussion (40%), • Report (50%), • Peer Review Report (10%)
Admission requirements for assessment	Presentation (10-15 min), 10-20 min discussion, Report (12-14 pages;6-8 weeks), Peer Review Report (1-5 Page)
Duration of Assessment	N/A
Language	English
Offering	Spring Semester
Lecturers	Pooja Rani, Research Staff
Person in charge	Pooja Rani, Research Staff
Duration of module	1 semester
Further modules	-
Range of Application	M. Sc. Wirtschaftsinformatik, Mannheim Master in Data Science
Semester	3rd semester