2. Detailed descriptions

i. Fundamentals Computer Science

CS 500	Advanced Software Engineering (Software Testing and Experimentation)
Form of module	Lectures, exercises and tutorials
Type of module	Computer Science Fundamental
Level	Master
ECTS	6
Workload	Hours per semester present: 56 h (2 + 2 SWS)
	Self-study: 112 h per semester • 28 h per semester for preparation and studying of lectures/tutorials • 84 h per semester for the preparation of the exams
Prerequisites	Knowledge of Java and/or Python
Aim of module	The course introduces the fundamental concepts and practices of software testing, and software experimentation / evaluation • Principles of Testing • Test Coverage Criteria • Test specification techniques • Model-based testing • Principles of Experimentation • Use of Software Observatoriums
Learning outcomes and qualification goals	Expertise: Students will be familiar with principles, approaches and tools for testing software and the methods and empirically evaluating software products, methods and tools (MK1, MK2)
	Methodological competence: Students will have the ability to judge, select, and apply traditional or non-traditional test tools and techniques to evaluate software quality, as well as to design and perform software experiments. (MF1) (MF1, MF3)
	Personal competence: Students will have improved skills in analytical thinking and applying theoretical knowledge to solve practical problems, especially in software testing and experimentation. (MKO3)
Media	Lecture notes, presentations, tool demonstrations, software, data sets

Literature	Paul Ammann & Jeff Offutt., "Introduction to Software Testing", Cambridge University Press, January 2008.
Methods	Lectures, weekly exercises, experimentation with different systems
Form of assessment	Written examination
Admission requirements for assessment	-
Duration of assessment	90 minutes
Language	English
Offering	Fall semester
Lecturer	Dr. Marcus Kessel, Prof. Dr. Colin Atkinson
Person in charge	Prof. Dr. Colin Atkinson
Duration of module	1 Semester
Further modules	Model-Driven Development, Generative Software Engineering
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st or 2nd semester

CS 530	Datenbanksysteme II *Database Systems II (DBSII)*
Form der Veranstaltung	Vorlesung mit Übung
Typ der Veranstaltung	Vertiefung
Modulniveau	Master
ECTS	6
Arbeitsaufwand	Präsenzstudium: 4SWS
	Eigenstudium: 56h pro Semester
	• davon Vor- und Nachbereitung der Veranstaltung und freies Selbststudium: 28h pro Semester
	• davon Vorbereitung für die Prüfung: 28 h pro Semester
Vorausgesetzte Kenntnisse	PI2, Algorithmen und Datenstrukturen, DBSI, C, C++
Lehrinhalte	Implementierung von Hauptspeicherdatenbanksystemen
Lern- und Kompetenzziele	Fachkompetenz: • effiziente C/C++ Programme entwickeln • physische Algebra • Implementierung von Indexstrukturen (MK1, MK3)
	Methodenkompetenz: • Analyse komplexer Algorithmen (MF1)
	Personale Kompetenz: • Präzises Analysieren (MKO1, MKO3)
Medienformen	Präsentationen mit Tafelanschrieb
Begleitende Literatur	Skript
Lehr- und Lernmethoden	Vorlesung
Art der Prüfungsleistung	Schriftliche Prüfung
Prüfungsvorleistung	-
Prüfungsdauer	90 Minuten (schriftliche Prüfung)
Sprache	Deutsch
Angebotsturnus	FSS
Lehrende/r	Prof. Dr. Guido Moerkotte
Modulverantwortlicher	Prof. Dr. Guido Moerkotte
Dauer des Moduls	1 Semester
Weiterführende Module	-
Verwendbarkeit	M.Sc. Wirtschaftsinformatik, Lehramt Informatik
Einordnung in Fachsemester	1./2./3. Fachsemester

CS 550	Algorithmics
Form of module	Lecture with tutorials
Type of module	Fundamental in Computer Science
Level	Master
ECTS	6
Workload	Attendance: 56 h per semester (4 h per week)
	Self-study: 112 h per semester • 28 h per semester for preparation and reworking of lectures/tutorials • 84 h per semester for the preparation of the exams
Prerequisites	Practical Informatics I, Algorithms and Data Structures, Linear Algebra, Statistics
Aim of module	The lecture deals with the design and the analysis of algorithms for various practically relevant computational problems and with methods for analyzing the complexity of certain problems. In particular, we will learn methods of formalizing discrete optimization problems and designing algorithms for them on the basis of analyzing the structure of these problems. Moreover, we will learn techniques for proving the correctness and estimating the running time of these algorithms. In the second part of the lecture, we will deal with the theory of NP-completeness with gives evidence that certain highly relevant problems do not have efficient algorithms. During the lecture we will derive algorithms and complexity-theoretic results for the following computational problems: • shortest path problems and shortest round tour problems • linear optimization problems • flow problem • matching problems • satisfiability problems • discreet linear optimization problems
Learning outcomes and qualification goals	Professional expertise: The students know efficient algorithms and the most important complexity-theoretic results for a number of computational problems which are highly relevant in practice. (MK1, MK2) Methodological competence:

The students learn to formalize informally specified computational problems, to analyse their structure with the goal to design efficient algorithms, to prove the correctness and to analyse the running time of given algorithms. Moreover, they learn to prove the NP-completeness of certain problems.
(MF1, MF3)

Personal competence:

Training of analytical, focussed, and precise thinking. Further development of abstraction abilities and the ability to transfer theoretical knowledge for solving practical problems, especially in the field of operations research. Increasing the sensitivity for the complexity and the efficient solvability of computational problems, especially through dealing with the theory of NP-completeness.
(MF1, MKO3)

Media	Lectures Slides and Exercises
Literature	• Cormen, Leiserson, Rivest, Stein: Introduction to Algorithms, 3rd edition
	• Shimon Even: Graph Algorithms
	• Lovasz, Plummer: Matching Theory
	• Handbooks on Operations Research and Management Science Volume 7 (Editors: Ball, Magnati, Monma, Nemhauser)
	• J. Toran: Das Erfüllbarkeitsproblem SAT, Lehmann Media, 2012
Methods	Reworking of lectures and tutorials, self-studies with literature, solving exercises at home and in cooperation with other students at the tutorials
Form of assessment	Written examination
Admission requirements for assessment	-
Duration of assessment	90 Minutes
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Matthias Krause
Person in charge	Prof. Dr. Matthias Krause
Duration of module	1 semester
Further modules	CS 651 – Cryptography II
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, M.Sc. Wirtschaftsmathematik, M.Sc. Wirtschaftspädagogik, Lehramt Informatik, M.Sc. Mathematik
Semester	1./ 2. semester

CS 560	Large-Scale Data Management
Form of module	Lecture with exercises
Type of module	Computer Science Fundamental
Level	Master
ECTS	6
Workload	In presence: 42h (2+2 SWS)
	Exercises and self-study: 119 h
Prerequisites	Database systems, algorithms & data structures, Java programming
Aim of module	This course introduces the fundamental concepts and computational paradigms of large-scale data management and Big Data. This includes methods for storing, updating, querying, and analyzing large dataset as well as for data-intensive computing. The course covers concept, algorithms, and system issues; accompanying exercises provide hands-on experience. Topics include: • Parallel and distributed databases • Parallel database design • Distributed query processing • Big data processing (including MapReduce, Spark, Streaming) • Distributed transactions • NoSQL databases
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge about methods and systems for working with large datasets and data-intensive computing. (MK1, MK2)
	Methodological competence: • Be able to judge, select, and use traditional and modern data management systems for a given data intensive task • Be able to solve computational problems involving large datasets (MF1)
	Personal competence: • Study independently (MKO3)
Media	Slide set, black board, exercise sheets, datasets, software
Literature	• T. Özsu, P. Valduriez: *Principles of Distributed Database Systems* Springer, 4th ed., 2020 • H. Garcia-Molina, J. D. Ullman, J. Widom *Database Systems: The Complete Book* Prentice Hall, 2nd ed., 2008

	• More in lecture notes
Methods	Lecture, weekly exercise, experimentation with different systems
Form of assessment	Written examination
Duration of assessment	90 minutes
Language	English
Offering	Fall semester
Lecturer	Prof. Dr. Rainer Gemulla
Person in charge	Prof. Dr. Rainer Gemulla
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 semester

CS 652	Data Security and Privacy
Form of module	Inverted classroom with exercises
Type of module	Fundamental in Computer Science
Level	Master
ECTS	6
Workload	Hours per semester present: 56h (4 SWS)
	Self-study: 112h
Prerequisites	There are no formal prerequisites but knowledge in cryptography or IT-security is recommended, e.g., by attending the lectures "Kryptographie I" or "Selected Topics in IT-Security"
Aim of module	Nowadays, users are more and more revealing data to the outside – either willingly as in the context of data mining or possibly unconsciously as in the case of the Internet of Things. The aim of the module is to raise awareness, in particular with respect to privacy violations. This is done by showing various security threats, e.g., traces left on the Internet such as the use of cookies or browser fingerprinting. In particular, the topic of privacy preservation will be covered. This includes discussing different approaches for defining the meaning of privacy but also possible countermeasures such as anonymization of data or the use of dedicated encryption schemes.
Learning outcomes and qualification goals	Expertise: Students will acquire the knowledge to identify security and privacy threats and to select and use appropriate countermeasures. (MK2)
	Methodological competence:
	Successful participants will be able to understand, to select, apply and evaluate the most appropriate techniques for a variety of different privacy-sensitive scenarios. In particular they are able to realize possible risks in new scenarios and to transfer given solutions to these. (MK1)
	Personal competence: The analytic, concentrated, and precise thinking of the students is trained. By the independent treatment of applications, e.g. in the course of the exercises, their abstraction capacity is further developed and the transfer of the learned material to related questions is trained. (MF1, MKO3)
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	FSS
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
Semester	1st/2nd/3rd semester

IE 500	Data Mining
Form of module	Lecture with exercises and project
Type of module	Business Informatics Fundamental
Level	Master
ECTS	6
Workload	Hours per semester: 56 h (4 SWS)
	Self-study per semester: 98 h • 70 h: pre and post lecture studying and revision • 28 h: examination preparation
Prerequisites	Foundations of Statistics, Practical Informatics I
Aim of module	The course provides an introduction to advanced data analysis techniques as a basis for analyzing business data and providing input for decision support systems. The course will cover the following topics: • Goals and Principles of Data Mining • Data Representation and Preprocessing • Classification • Regression • Cluster Analysis • Association Analysis • Practical Data Mining using Python
Learning outcomes and qualification goals	Expertise: Students will acquire basic knowledge of the techniques, opportunities, and applications of data mining. (MK1, MF1)
	Methodological competence: Successful participants will be able to identify opportunities for applying data mining in an enterprise environment, select and apply appropriate techniques, and interpret the results. project organization skills (MK2, MF3, MF4, MKO1)
	Personal competence: team work skills presentation skills (MKO2, MF2)
Media	Slide set, exercise sheets, Jupyter notebooks, data sets for the exercises, lecture videos
Literature	• Pang-Ning Tan, Michael Steinback, Vipin Kumar: Introduction to Data Mining, 2nd Edition, Pearson. • Aurélien Géron: Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow, 3rd Edition, O'Reilly.

Methods	The course consists of a lecture together with accompanying practical exercises as well as student team projects. In the exercises the participants will gather initial expertise in applying state of the art data mining tools on realistic data sets. The group projects take place in the last third of the term. Within the projects, students implement advanced data mining projects of personal choice and report about the results of their projects in the form of a written report as well as an oral presentation.
Form of assessment	Written examination (75%), project report (20%), oral project presentation (5%)
Admission requirements for assessment	-
Duration of assessment	60 minutes (written examination), 5-11 pages (project report), 5-15 minutes (oral project presentation)
Language	English
Offering	Fall semester / Spring semester
Lecturer	Prof. Dr. Heiko Paulheim; Prof. Dr. Christian Bizer; Dr. Sven Hertling
Person in charge	Prof. Dr. Heiko Paulheim; Prof. Dr. Christian Bizer; Dr. Sven Hertling
Duration of module	1 Semester
Further modules	IE 675b – Machine Learning, IE 678 – Deep Learning, IS 661 – Text Analytics, CS 646 – Higher Level Computer Vision, IE 671 – Web Mining
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st/2nd semester

IE 560	Foundations of Artificial Intelligence – Reasoning and Decision Making
Form of module	Inverted classroom
Type of module	Business Informatics Fundamental
Level	Master
ECTS	6
Workload	Hours per semester: 50 h (2+2 SWS)
	Self-study per semester: 120 h
	• 80 h: pre- and post lecture studying and revision
	• 40 h: exam preparation
Prerequisites	Linear Algebra, Basic Probability Theory, Basic Knowledge of Propositional Logic,
Aim of module	The course provides an introduction to methods for AI-based decision making as a basis for the design of automated decision making and decision support systems. The course will cover the following topics:
	• Decision Problems and Bounded Rationality
	• Propositional Logic
	• Probability Theory
	• Probabilistic Graphical Models
	• Utility and Decision Theory
	• Game Theory
	• Markov Decision Processes
	• Reinforcement Learning
Learning outcomes and qualification goals	Expertise:
	Students will acquire basic knowledge of the techniques, opportunities, and applications of AI-based decision making.
	(MK1, MF1)
	Methodological competence:
	Successful participants will be able to identify opportunities for decision support in an enterprise environment, select and apply appropriate techniques, and interpret the results.
	(MK2, MF3, MF4, MKO1)
	Personal competence: none
Media	Lecture videos, slide set, exercise sheets, software tools
Literature	S. Russel and P. Norvig: AI a modern Approach (3rd Edition), 2010 (selected sections)

Methods	The course consists of a lecture accompanied by practical homework and case studies. In the lecture, the students' basic concepts and methods of decision theory will be explained both in theory and using concrete examples. The students will practice and test their knowledge acquired in the lecture in homework assignments. Within the case studies, students model real world decision problems and try to solve them optimally using methods from the lecture.
Form of assessment	Written exam
Admission requirements for assessment	Midterm exam: 45 minutes (propositional logic and probability theory)
Duration of assessment	90 minutes
Language	English
Offering	Fall semester
Lecturer	Prof. Dr. Heiner Stuckenschmidt
Person in charge	Prof. Dr. Heiner Stuckenschmidt
Duration of module	1 Semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science,
Semester	1st/2nd semester

2. Detailed descriptions

i. CS-Courses

CS 600	Model-Driven Development
Form of module	Lectures with accompanying tutorials
Type of module	Specialization course
Level	Master
ECTS	6
Workload	Hours per semester present at university: 56 h (4 SWS)
	Self-study: 112 h semester • 28 h: pre and post lecture studying and revision • 56 h: tutorial exercises • 28 h: directed independent study (reading papers, books etc.)
Prerequisites	Software Testing and Experimentation
Aim of module	The course focuses on the principles, practices and tools involved in advanced model-driven development. This includes established modelling standard languages (e. g. UML, ATL, OCL) and modelling infrastructures (e. g. MOF, EMF, …) as well as leading edge, state-of-the-art modelling technologies (e. g. LML, PLM . . .). Key topics addressed include: • Principles of Model-Driven Development • Meta-Modeling • Domain-Specific Languages • Model Constraint and Transformation languages • Multi-View/Multi-Paradigm Modeling • Multi-Level Modeling • Ontology Modeling • Enterprise Architecture Modeling
Learning outcomes and qualification goals	Expertise: Students will be familiar with the accepted best practices and technologies used in mainstream model-driven development as well as state-of-the-art modeling technologies emerging from research institutions. (MK1, MK2)
	Methodological competence: Students will know how to apply modeling technologies in real-world projects. (MF1, MF3)
	Personal competence:

	Students will have the capability to analyse, understand and model complex systems. (MKO1)
Media	Printed Lecture Notes, Presentations, Tool Demonstrations
Literature	• Jos B. Warmer and Anneke G. Kleppe, The Object Constraint Language: Getting Your Models Ready for MDA, Addison-Wesley Object Technology Series, 2003
Methods	Lectures, tutorials, independent study
Form of assessment	Written examination
Admission requirements for assessment	-
Duration of assessment	90 minutes
Language	English
Offering	Fall semester
Lecturer	Prof. Dr. Colin Atkinson
Person in charge	Prof. Dr. Colin Atkinson
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	2nd, 3rd or 4th semester

CS 606	Foundations of Artificial Intelligence: Search and Problem Solving
Form der Veranstaltung	Vorlesung mit Übung
Typ der Veranstaltung	Vertiefung Informatik
Modulniveau	Master
ECTS	6
Arbeitsaufwand	Präsenzstudium: 56 h pro Semester (4 SWS)
	Eigenstudium: ca. 98 h pro Semester
	• davon Vor- und Nachbereitung der Veranstaltung und freies Selbststudium: 70 h pro Semester
	• davon Vorbereitung für die Prüfung, z.B. Prüfungs-/Seminarabschlussarbeits- und Präsentationsvorbereitung: 28 h pro Semester
Vorausgesetzte Kenntnisse	Formale Grundlagen der Informatik (insbes. Komplexität, Graphen und Logik), Algorithmen und Datenstrukturen, Programmierpraktikum I & II
Lehrinhalte	• Problemeigenschaften und Problemtypen
	• Problemlösen als Suche, Anwendung im Bereich Spiele
	• Constraintprobleme und deren Lösung
	• Logische Constraints
	• Entscheidungsbaumlernen
Lern- und Kompetenzziele	Fachkompetenz:
	Ziele und Grundlagen der Künstlichen Intelligenz. Suchverfahren als universelle Problemlösungsverfahren. Problemkomplexität und Heuristische Lösungen. Eigenschaften und Zusammenhang zwischen unterschiedlichen Suchverfahren.
	(BK7)
	Methodenkompetenz:
	Beschreibung konkreter Aufgaben als Such-, Constraint- oder Planungsproblem. Implementierung unterschiedlicher Suchverfahren und Heuristiken.
	(BF1, BKO1)
	Personale Kompetenz:
	-
Medienformen	Lehrbuch, Vorlesung, Präsentationen, Tafel
Begleitende Literatur	• Russel and Norvig: Artificial Intelligence – a modern approach. Prentice Hall. 3rd Edition 2010.
Lehr- und Lernmethoden	Vorlesung, praktische Übungen, Eigenständige Bearbeitung von Übungsaufgaben
Art der Prüfungsleistung	Schriftliche Prüfung
Prüfungsvorleistungen	• 1-2 Mini-Projekte erfolgreich bearbeitet und dokumentiert
	• Mindestens 60% aller Aufgabenpunkte aufsummiert

Prüfungsdauer	90 Minuten
Sprache	Deutsch/Englisch
Angebotsturnus	Herbstsemester
Lehrende/r	Dr. Christian Meilicke
Modulverantwortlicher	Prof. Dr. Heiner Stuckenschmidt
Dauer des Moduls	1 Semester
Weiterführende Module	SM 442 Bachelorseminar Prof. Stuckenschmidt
Verwendbarkeit	M. Sc. Wirtschaftsinformatik, B.Sc. Wirtschaftsinformatik, M. Sc. Wirtschaftspädagogik, Lehramt Informatik, Beifach Angewandte Informatik
Einordnung in Fachsemester	5./6. Fachsemester im B.Sc. Wirtschaftsinformatik, 1.2.3. Fachsemester im M. Sc. Wirtschaftsinformatik

CS 630	Generative Software Engineering
Form of module	Lectures, exercises, tutorials and projects
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 h (2 + 2 SWS)
	Self-study: 112 h per semester 28 h per semester for preparation and studying of lectures/tutorials 84 h per semester for the preparation of the exams
Prerequisites	• Software Testing and Experimentation • Knowledge of Java and/or Python
Aim of module	The course introduces the fundamental principles, practices and applications of generative software engineering (GSE) as well as the supporting models, tools and services - • Software Recommendation and Reuse • Code Search Engines • Principles of GSE • Existing GSE models, tools and services • Defining GSE "problems" • Applications of GSE • Evaluation and comparison of GSE models, tools and services
Learning outcomes and qualification goals	Expertise: Students will be familiar with the principles, practices and applications of GSE as well as supporting models, tools and services. (MK1, MK2)
	Methodological competence: Students will have the ability to judge, select, and apply GSE techniques and tools in practical software engineers, as well as the ability to understand academic GSE publications and to perform research in GSE. (MF1, MF2, MF3)
	Personal competence: Students will have improved skills in analytical thinking and applying theoretical knowledge to solve practical problems, especially in the use of AI to enhance software engineering. (MKO1, MKO3)

Media	Students acquire knowledge of the principles, practices and applications of GSE, including supporting models, tools and services and methods, through lectures and tutorials. The students apply their knowledge individually and in team projects and report their findings in written reports and oral presentations.
Literature	
Methods	Lectures, weekly exercises, experimentation with different systems
Form of assessment	Project reports (70%), oral presentations (30%)
Admission requirements for assessment	
Duration of assessment	
Language	English
Offering	Spring semester
Lecturers	Dr. Marcus Kessel
Person in charge	Dr. Marcus Kessel
Duration of module	1 Semester
Further modules	Model-Driven Development, Software Testing and Experimentation
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	2nd, 3rd or 4th semester

CS 646	Higher Level Computer Vision
Form of module	Lecture with Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4SWS)
	Self-study: 98h • 70h lecture/exercises • 28h exam preparation
Prerequisites	Basis skills in linear algebra, basis knowledge in python and pytorch
Aim of module	• Point Features and point matching • Object Identification • Deep Learning for Computer Vision • Object Detection • Image Segmentation • Optical Flow • Video and Motion Segmentation
Learning outcomes and qualification goals	Expertise: The students have a detailed understanding of Computer Vision techniques. They can evaluate given Computer Vision algorithms. (MK1, MK2, MF1, MF3)
	Methodological competence: Students understand the technical basis of Computer Vision algorithms; they can explain the discussed methods and implement them. (MF1, MF2, MF3)
	Personal competence: Understanding complex Computer Vision problems; thorough judgment in the design and use of methods; can work efficiently in a team. (MK01, MK02)
Media	Exercise sheets and lecture slides are available online.
Literature	• Goodfellow et al..: Deep Learning, MIT Press, 2016. https://www.deeplearningbook.org/
	• R. Szeliski: Computer Vision Algorithms and Applications, Springer, 2010. ISBN: 978-1-84882-934-3. (Online available: http://szeliski.org/Book/
	• D. Forsyth, J. Ponce: Computer Vision: A Modern Approach, Prentice Hall, 2nd edition, 2012. ISBN: 978-0136085928 (Online available: http://cmuems.com/excap/readings/forsyth-ponce-computer-vision-a-modern-approach.pdf

	• R. Hartley, A. Zisserman: Multiple View Geometry in Computer Vision, Cambridge University Press, 2nd edition, 2004.
Methods	Lecture, weekly exercise, book studies, implementation of algorithms, visualization of results
Form of assessment	written examination
Admission requirements for assessment	-
Duration of assessment	90 minutes (written)
Language	English
Offering	Fall semester
Lecturer	Professor Dr.-Ing. Margret Keuper
Person in charge	Professor Dr.-Ing. Margret Keuper
Duration of module	1 Semester
Further modules	Image Processing, Generative Computer Vision Models
Range of application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

CS 647	Image Processing
Form of module	Lecture with Exercise (partially online)
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4SWS)
	Self-study: 98h • 70h lecture/exercises • 28h exam preparation
Prerequisites	Basis skills in linear algebra, basis knowledge in python
Aim of module	• Introduction to Imaging (human visual system, optics, sensors) • Noise and basic operations (convolution, correlations, gradients) • Energy minimization • Variational Methods • Feature extraction • Classification • Segmentation • Stereo Vision
Learning outcomes and qualification goals	Expertise: The students have a detailed understanding of image and video processing techniques. They can evaluate given image processing algorithms. (MK1, MK2, MF1, MF3)
	Methodological competence: Students understand the technical basis of image processing algorithms; they can explain the discussed methods and implement them. (MF1, MF2, MF3)
	Personal competence: Understanding complex Image Processing problems; thorough judgment in the design and use of methods; can work efficiently in a team. (MK01, MK02)
Media	Exercise sheets and lecture slides available online.
Literature	• R. Szeliski: Computer Vision Algorithms and Applications, Springer, 2010. ISBN: 978-1-84882-934-3. (Online available: http://szeliski.org/Book/)
	• D. Forsyth, J. Ponce: Computer Vision: A Modern Approach, Prentice Hall, 2nd edition, 2012. ISBN: 978-0136085928
Methods	Lecture, weekly exercise, book studies, implementation of algorithms, visualization of results

Form of assessment	written examination
Admission requirements for assessment	-
Duration of assessment	90 minutes
Language	English
Offering	Spring Semester
Lecturer	Professor Dr.-Ing. Margret Keuper
Person in charge	Professor Dr.-Ing. Margret Keuper
Duration of module	1 Semester
Further modules	Higher Level Computer Vision, Generative Computer Vision Models
Range of application	B. Sc. Wirtschaftsinformatik, M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

CS 651	Cryptography II
Form of module	Inverted classroom
Type of module	Specialization course
Level	Master
ECTS	6
Workload	Hours per semester present: 56h (4 SWS) Self-study: 112h
Prerequisites	Even though the lecture deepens and continues topics discussed in *"CS 404 Cryptography I"*, it is not a prerequisite to have attended this lecture. The lecture *"Cryptography II"* can be studied without any prior knowledge on cryptography – all necessary basics are shortly recapitulated.
Aim of module	The goal of this lecture is to present and discuss important scientific concepts from modern cryptography. This includes: • Security Definitions: How can the security of cryptographic schemes formally defined? • Proofs of Security: How can the security of cryptographic schemes be proven (based on precise assumptions)? • Cryptanalysis: What are the established techniques to analyze cryptographic mechanisms? • Elliptic Curves • Zero-Knowledge Proofs
Learning outcomes and qualification goals	Expertise: With the help of current techniques and theories of modern cryptography, the students can assess the security of cryptographic processes and assess security statements accordingly. Furthermore, they can identify security goals and use appropriate techniques that could not be dealt with in "*CS 404 Cryptography I*". (MK2) Methodological competence: The students can select and use suitable methods for the security analysis of cryptographic processes. This includes, for example, the choice of the appropriate security model, proof of security based on clearly specified assumptions and the analysis of given procedures. In particular, the students can understand and assess the security arguments for existing procedures and to transfer them to new ones. Furthermore, they can use techniques and protocols to achieve security goals that were not yet possible with the methods discussed in *"CS 404 Cryptography I"*. (MK1) Personal competence:

	The analytic, concentrated, and precise thinking of the students is trained. By the independent treatment of applications, e.g. in the course of the exercises, their abstraction capacity is further developed and the transfer of the learned material to related questions is trained.
	(MF1, MKO3)
Media	Video recordings, annotated lecture slides
Literature	• Jonathan Katz, Yehuda Lindell: Introduction to Modern Cryptography: Principles and Protocols, Chapman and Hall/CRC, 2007.
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	Oral exam
Admission requirements for assessment	none
Duration of assessment	30 minutes
Language	English
Offering	HWS
Lecturer	Prof. Dr. Frederik Armknecht
Person in charge	Prof. Dr. Frederik Armknecht
Duration of module	One term
Further modules	none
Range of application	M.Sc. Mannheim Master in Data Science, M.Sc. Wirtschaftsinformatik, Lehramt Informatik, M.Sc. Mathematik
Semester	1st/2nd/3rd semester

CS 655	Cryptography
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	Basis skills in linear algebra, probability theory, algorithms, and data structures
Aim of Module	• Basic concepts of cryptography • Mathematical Background • Basics of Information Theory • Block Ciphers (DES, AES, etc.) • Stream Ciphers • Secure Key Exchange Protocols (Diffie-Hellman protocol, etc.) • Public Key encryption (RSA) • Cryptographic Hash Functions • Signature Systems and Message Authentication Codes
Learning Outcomes and qualification goals	Expertise: After the course the students are able to identify security risks in various modern scenarios of data traffic like online banking, wireless communication, online trade ... (MK1)
	Methodological competence: The students are able to formulate and formalize security goals for various use cases and to choose and to apply appropriate methods to reach these goals. Examples here are to provide data security data encryption, to establish trusted electronical data encryption, to establish trusted electronical communication channels, or to apply methods for secure authentication (MF1)
	Personal competence: The course trains abstract thinking and the ability to formally model application scenarios. By solving exercises independently, the transfer of the learned material to related questions is promoted.
Media	Exercise sheets and lecture slides available online, blackboard
Literature	• Christof Paar, Bart Preneel, Jan Pelzl: Understanding Cryptography: A Textbook for Students and Practitioners, Springer 2009 • Douglas R. Stinson: Cryptography - Theory and Practice, Taylor & Francis, 2005

	• Alan G. Konheim: Cryptography: A Primer, John Wiley & Sons, 1981
Methods	Lecture, exercises every two weeks, book studies
Form of assessment	Oral examination
Admission requirements for assessment	-
Duration of assessment	15 – 30 minutes
Language	English
Offering	FSS
Person in Charge	Prof. Dr. Matthias Krause
Duration of Module	1 Semester
Further Modules	Cryptography II
Range of Application	M.Sc Business Informatics, M.Sc Data Science, Lehramt Informatik, B.Sc. Wirtschaftsmathematik
Semester	1st/2nd/3rd Semester

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	Expertise: Students will acquire profound knowledge of Blockchain technology as well as the skills to critically examine the security of Blockchain-based systems. (MK1, MK2)
	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. (MKO3)
	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. (MF1)
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 668	Generative Computer Vision Models
Form of module	Lecture with Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4SWS)
	Self-study: 98h • 70h lecture/exercises • 28h exam preparation
Prerequisites	Basis skills in linear algebra, basis knowledge in python/pytorch
Aim of module	• Introduction to Clustering and Unsupervised Learning • Introduction to Generative Models • Autoregressive Models for Image Generation • (Normalizing) Flow • Latent Variable Models • Latent Space Visualizations • Generative Adversarial Models • Diffusion Models • Multi-Modal Conditioning
Learning outcomes and qualification goals	Expertise: The students have a detailed understanding of image generation techniques, latent variable models, and their evaluations. (MK1, MK2, MF1, MF3)
	Methodological competence: Students understand the technical basis of generative models; they can explain the discussed methods and implement them. (MF1, MF2, MF3)
	Personal competence: Understanding image generative models, their working principles and training procedures; thorough judgment in the design and use of methods; Students can work efficiently in a team. (MK01, MK02)
Media	Exercise sheets and lecture slides available online.
Literature	Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT press book, 2016.
Methods	Lecture, weekly exercise, book studies, implementation of algorithms, visualization of results
Form of assessment	Written
Admission requirements for assessment	-
Duration of assessment	90 minutes

Language	English
Offering	Spring Semester
Lecturer	Professor Dr.-Ing. Margret Keuper
Person in charge	Professor Dr.-Ing. Margret Keuper
Duration of module	1 Semester
Further modules	Higher Level Computer Vision
Range of application	M. Sc. Wirtschaftsinformatik, M. Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

ii. IE-Courses

IE 630	**Anfrageoptimierung** *Query Optimization*
Form der Veranstaltung	Vorlesung mit Übung
Typ der Veranstaltung	Vertiefung
Modulniveau	Master
ECTS	6
Arbeitsaufwand	Präsenzstudium: 4SWS
	Eigenstudium: 56h pro Semester
	• davon Vor- und Nachbereitung der Veranstaltung und freies Selbststudium: 28h pro Semester
	• davon Vorbereitung für die Prüfung: 28 h pro Semester
Vorausgesetzte Kenntnisse	DBSI, Kombinatorik, Statistik
Lehrinhalte	Grundlagen der Anfrageoptimierung
Lern- und Kompetenzziele	Fachkompetenz: • Suchraumgroessen abschaetzen • Komplexitaetsanalysen • Indexeinsatz (MK1, MK2)
	Methodenkompetenz: • systematisches Auszaehlen und Aufzaehlen • Analyse komplexer Algorithmen (MF1, MF2, MF3, MF5)
	Personale Kompetenz: • Präzises Analysieren (MKO1, MKO3)
Medienformen	Präsentationen mit Tafelanschrieb
Begleitende Literatur	Skript
Lehr- und Lernmethoden	Vorlesung (2 SWS)
Art der Prüfungsleistung	Mündliche Prüfung
Prüfungsvorleistung	-
Prüfungsdauer	30 Minuten (mündliche Prüfung)
Sprache	Deutsch
Angebotsturnus	FSS
Lehrende/r	Prof. Dr. Moerkotte
Modulverantwortlicher	Prof. Dr. Moerkotte
Dauer des Moduls	1 Semester
Weiterführende Module	-
Verwendbarkeit	M.Sc. Wirtschaftsinformatik

Einordnung in Fachsemester	1./2./3. Fachsemester

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; Dr. Sven Hertling
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

IE 663	Information Retrieval and Web Search
Form of module	Lecture
Type of module	Specialization course
Level	Master
ECTS	3
Workload	Hours per semester present: 28h (2SWS)
	Self-study: 60h per semester • Pre- and post- lecture studying and preparation (30h) • Examination preparation (30h)
Prerequisites	Fundamental notions of linear algebra, probability theory, as well as algorithms and data structures
Aim of module	Given the vastness and richness of the Web, users need high-performing, scalable and efficient methods to access its wealth of information and satisfy their information needs. As such, being able to search and effectively retrieve relevant pieces of information from large text collections is a crucial task for the majority of Web applications. In this course, we will explore a variety of techniques for text-based information retrieval and Web search. Covered topics will include: • Efficient text indexing; • Boolean and vector space retrieval models; • Probabilistic and semantic ad-hoc retrieval; • Evaluation of retrieval systems; • Text classification and clustering; • Web search, crawling and link-based algorithms. This course provides theoretical information retrieval foundations. As such is highly to be attended together with the course Information Retrieval Project (IE 691).
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge of fundamental techniques of Information Retrieval and Web Search, including standard retrieval models, evaluation of information retrieval systems, text classification and clustering, as well as web search topics such as crawling and link-based algorithms. (MK1, MK2)
	Methodological competence: Successful participants will be able to understand state-of-the-art methods for Information Retrieval and Web search, as well as being able to select, apply and evaluate the most appropriate techniques for a variety of different search scenarios. (MF1, MF3)

	Personal competence: -
Media	Lecture slides, exercise sheets
Literature	• Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008. • R. Baeza-Yates, B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 2011 (2nd Edition).
Methods	The course consists of (1) lectures that introduce the students to traditional and contemporary information retrieval techniques and models, and (2) exercises in which the students are demonstrated in terms of comprehensible examples how theoretically introduced models work.
Form of assessment	Written examination
Admission requirements for assessment	-
Duration of assessment	90 minutes
Language	English
Offering	Fall semester
Lecturer	Prof. Dr. Simone Paolo Ponzetto
Person in charge	Prof. Dr. Simone Paolo Ponzetto
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, MMDS, MMSDS, Lehramt Informatik
Semester	1st/2nd/3rd semester

IE 670	Web Data Integration
Form of module	Lecture
Type of module	Specialization course
Level	Master
ECTS	3
Workloadk	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	-
Aim of module	Data integration is one of the key challenges in most IT projects and it is estimated that data scientists spend about 80% of their time on data integration and data preparation. Within the enterprise context, data integration problems arise whenever data from separate sources needs to be combined as the basis for new applications or data analysis projects. Within the context of the Web, data integration techniques form the foundation for taking advantage of the ever-growing number of publicly-accessible data sources. The course will cover the following topics: 1. Heterogeneity and Distributedness 2. The Data Integration Process 3. Structured Data on the Web 4. Data Exchange Formats 5. Schema Mapping and Data Translation 6. Identity Resolution 7. Data Quality Assessment 8. Data Fusion It is highly recommended to attend the course IE683 Web Data Integration 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 Web data in business applications and will learn to select and apply appropriate techniques for integrating and cleansing Web data. (MK1, MF1)
	Methodological competence: Participants will acquire knowledge of the data integration process as well as the techniques that are used in each phase of the process.

	(MK2, MF3, MF4, MKO3)
	Personal competence: -
Media	slide set
Literature	• AnHai Doan, Alon Halevy, Zachary Ives: Principles of Data Integration. Morgan Kaufmann, 2012. • Luna Dong, Divesh Srivastava: Big Data Integration. Morgan & Claypool, 2015. • Ulf Leser, Felix Naumann: Informationsintegration. Dpunkt Verlag, 2007.
Methods	The course consists of a lecture that introduces students to state of the art data integration techniques.
Form of assessment	Written examination
Admission requirements for assessment	-
Duration of assessment	60 minutes
Language	English
Offering	Fall semester
Lecturer	Prof. Dr. Christian Bizer
Person in charge	Prof. Dr. Christian Bizer
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

IE 671	Web Mining
Form of module	Lecture and Exercise
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 and presentation preparation
Prerequisites	IE 500 Data Mining I (recommended). Fundamental notions of linear algebra and probability theory.
Aim of module	The vast amounts of textual content and structured data found on the Web provide us with a goldmine of data that can be mined to derive knowledge about nearly every aspect of human life. The course covers techniques for extracting knowledge from Web content as a basis for business decisions and applications. The course will cover the following topics: Web Usage Mining (including Recommender Systems), Web Structure Mining (including Social Network Analysis), and Web Content Mining (including Sentiment Analysis and Hate Speech Detection). NOTE: It is highly recommended to attend the module "Web Mining Project" in the same semester since the schedule and topics of both modules are aligned.
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge of the techniques, opportunities, and applications of Web mining. (MK1, MF1)
	Methodological competence: Successful participants will be able to identify opportunities for mining knowledge from Web content, select and apply appropriate techniques and interpret the results. (MK2, MF3, MF4)
	Personal competence:
Media	slide set, exercise sheets, data sets for the exercises
Literature	• Bing Liu: Web Data Mining. 2nd Edition, Springer, 2011. • Wouter de Nooy, et al.: Exploratory Social Network Analysis with Pajek. 2nd Edition, Cambridge University Press, 2011. • Bing Liu. Sentiment Analysis and Opinion Mining, Morgan & Claypool Publishers, 2012.

Methods	The course consists of a lecture together with accompanying practical exercises as well as student team projects. In the exercises the participants will gather initial expertise in applying state of the art web mining tools.
Form of assessment	Written examination
Admission requirements for assessment	-
Duration of assessment	60 minutes
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Christian Bizer
Person in charge	Prof. Dr. Christian Bizer
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 675b	Machine Learning
Form of module	Lecture with exercises
Type of module	Specialization Course
Level	Master
ECTS	9
Workload	In presence: 63 h (4+2 SWS)
	Exercises, assignments, and self-study: 167 h
Prerequisites	IE 500 Data Mining I (recommended) probability/linear algebra
Aim of module	Machine learning is concerned with building computer systems that improve with experience as well as the study of learning processes, including the design of algorithms that are able to make predictions or extract knowledge from data. The aim of this module is to provide an introduction into the field of machine learning, and study algorithms, underlying concepts, and theoretical principles. Topics include: • Basics of machine learning • Inference and decision • Selected classification and regression models • Parameter estimation • Dimensionality reduction (SVD, PCA, FA) • Mixture models and EM • Kernels and vector machines • Hyperparameter optimization
Learning outcomes and qualification goals	Expertise: • Deep understanding of algorithms and underlying concepts of machine learning (MK1, MF1)
	Methodological competence: • Being able to apply machine learning techniques and systems for a given problem • Being able to model and implement new machine learning techniques (MK2, MF3, MF4)
	Personal competence: • writing skills • presentation skills • statistical programming skills (MKO3, MF2)
Media	Slide set, exercise sheets, software, datasets
Literature	• K.P. Murphy. *Probabilistic Machine Learning: An Introduction*. The MIT Press, 2022

	• I. Goodfellow, Y. Bengio, A. Courville. *Deep Learning*, The MIT Press, 2017 • Additional material and articles provided in lecture notes
Methods	The course consists of a lecture accompanied by theoretical and practical exercises as well as case studies with real data. In the exercises, students will deepen the material discussed in the lecture, apply the methods in practice, and present the result.
Form of assessment	Written examination
Admission requirements for assessment	Homework assignments (pass at least 3 assignments)
Duration of assessment	120 minutes
Language	English
Offering	Fall semester
Lecturer	Prof. Dr. Rainer Gemulla
Person in charge	Prof. Dr. Rainer Gemulla
Duration of module	1 Semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	1st/2nd/3rd semester

IE 678	Deep Learning
Form of module	Lecture with exercises
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester: 42h (2+2 SWS)
	Exercises, assignments, and self-study: 119 h
Prerequisites	IE 675b Machine Learning or equivalent
Aim of module	Machine learning is concerned with building computer systems that improve with experience as well as the study of learning processes, including the design of algorithms that are able to make predictions or extract knowledge from data. Building upon IE 675b Machine Learning, this course focuses on deep learning and introduces basic and advanced deep learning architectures and techniques, training methods and hyperparameter optimization, as well as selected applications. Topics include: • Feedforward neural networks • Backpropagation and parameter optimization • Machine learning systems • Training techniques for deep learning models • Recurrent neural networks • Convolutional neural networks • Attention and Transformers • Deep learning for graphs • Deep generative modelling
Learning outcomes and qualification goals	Expertise: • Deep understanding of fundamental concepts, models, and algorithms of deep learning (MK1, MF1)
	Methodological competence: • Being able to build and train deep learning models • Being able to select suitable deep learning techniques for a given learning problem (MK2, MF3, MF4)
	Personal competence: • writing skills • presentation skills • statistical programming skills (MKO3, MF2)
Media	Slide set, exercise sheets, software, datasets

Literature	• I. Drori. *The Science of Deep Learning*. Cambridge University Press, 2023 • I. Goodfellow, Y. Bengio, A. Courville. *Deep Learning*, The MIT Press, 2017 • K.P. Murphy. *Probabilistic Machine Learning: An Introduction*. The MIT Press, 2022 • K.P. Murphy. *Probabilistic Machine Learning: Advanced Topics*. The MIT Press, 2023 • Additional material and articles provided in lecture notes
Methods	The course consists of a lecture accompanied by theoretical and practical exercises as well as case studies with real data. In the exercises, students will deepen the material discussed in the lecture, apply the methods in practice, and present the result.
Form of assessment	Oral examination
Admission requirements for assessment	Homework assignments (pass at least 2 assignments)
Duration of assessment	25 minutes
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Rainer Gemulla
Person in charge	Prof. Dr. Rainer Gemulla
Duration of module	1 Semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	2nd/3rd semester

IE 683	Web Data Integration Project
Form of module	Project
Type of module	Specialization course
Level	Master
ECTS	3
Workload	Hours per semester: 28 h (2 SWS)
	Self-study: 56 h per semester • 36 h: project work • 20 h: report writing and presentation preparation
Prerequisites	Programming skills in Python
Aim of module	The web data integration project allows students to apply the methods and techniques that they have learned in the lecture Web Data Integration in the context of a practical integration project. The projects cover all steps of the data integration process including data gathering, schema mapping, data translation, identity resolution, data quality assessment, and data fusion. It is highly recommended to attend the web data integration lecture (IE670) in the same semester as the web data integration project 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 Web data in business applications and will learn to apply appropriate techniques for integrating and cleansing Web data. (MK1, MF1)
	Methodological competence: • Participants will acquire knowledge of the data integration process as well as the techniques that are used in each phase of the process. • project organization skills (MK2, MF3, MF4, MKO3)
	Personal competence: • presentation skills • team work skills (MKO2, MF2)
Media	exercise sheets; Java project template
Literature	• AnHai Doan, Alon Halevy, Zachary Ives: Principles of Data Integration. Morgan Kaufmann, 2012. • Luna Dong, Divesh Srivastava: Big Data Integration. Morgan & Claypool, 2015.

	• Ulf Leser, Felix Naumann: Informationsintegration. Dpunkt Verlag, 2007.
Methods	Students work on their integration projects in teams and will report about the results of their projects in the form of a written report as well as an oral presentation.
Form of assessment	Project report (70%, 10-20 pages in length), oral project presentation (30%, 15-20 minutes)
Admission requirements for assessment	-
Duration of assessment	-
Language	English
Offering	Fall semester
Lecturer	Prof. Dr. Christian Bizer
Person in charge	Prof. Dr. Christian Bizer
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, Mannheim Master in Data Science, Mannheim Master in Social Data Science, Lehramt Informatik
Semester	1. /2. /3. Semester

IE 684	Web Mining Project
Form of module	Project
Type of module	Specialization course
Level	Master
ECTS	3
Workload	Hours per semester: 28 h (2 SWS)
	Self-study: 56 h per semester • 36 h: project work • 20 h: report writing and presentation preparation
Prerequisites	Programming skills in Java or Python. IE 671 Web Mining (recommended).
Aim of module	The Web Mining project allows students to apply the methods and techniques that they have learned in the lecture Web Mining in the context of a practical integration project. The projects can cover any of the topic of Web usage, content or structure mining. NOTE: It is highly recommended to attend the module IE 671 "Web Mining" in the same semester since the schedule and topics of both modules are aligned.
Learning outcomes and qualification goals	Expertise: • Students will be able to identify opportunities for employing Web Mining techniques in business applications and will learn to apply appropriate techniques for mining Web data. (MK1, MF1)
	Methodological competence: • Participants will acquire practical knowledge of techniques for mining Web data. • Project organization skills (MK2, MF3, MF4, MKO3)
	Personal competence: • Presentation skills • Team work skills (MKO2, MF2)
Media	Slide set with references to potential topics, datasets, etc.
Literature	• Bing Liu: Web Data Mining. 2nd Edition, Springer, 2011. • Wouter de Nooy, et al.: Exploratory Social Network Analysis with Pajek. 2nd Edition, Cambridge University Press, 2011. • Bing Liu. Sentiment Analysis and Opinion Mining, Morgan & Claypool Publishers, 2012.

Methods	Students work on their projects in teams and report about the results of their projects in the form of a written report as well as an oral presentation.
Form of assessment	Project report (70%, 5-15 pages in length), oral project presentation (30%, 10-90 minutes).
Admission requirements for assessment	-
Duration of assessment	4-6 weeks (execution of the project work and writing of the report), 10-90 minutes (presentation).
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Christian Bizer
Person in charge	Prof. Dr. Christian Bizer
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, Mannheim Master in Data Science Lehramt Informatik, MMSDS
Semester	1. /2. /3. Semester

IE 686	Large Language Models and Agents
Form of module	Lectures with tutorials and projects
Type of module	Specialization course
Level	Master
ECTS	3
Workload	Hours per semester: 28 h (2 SWS) Self-study: 56 h per semester • 36 h: project work • 20 h: report writing and presentation preparation
Prerequisites	• Programming skills in Python • Basic machine learning concepts and techniques
Aim of module	Large language models (LLMs) such as GPT, Claude, Llama, Gemini, and Mistral 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 and teaches them how to employ the models within applications. The course covers the following topics: • Introduction to LLMs • Instruction tuning and reinforcement learning from human feedback • Prompt engineering and efficient adaptation • Evaluation of LLMs and agents • Development of LLM-based applications
Learning outcomes and qualification goals	Expertise: Students will understand the principles of training LLMs. They will be able to identify opportunities for employing LLMs in business applications and will learn to apply prompt engineering techniques as well as agent frameworks for solving business tasks. (MK1, MF1)
	Methodological competence: Participants will acquire theoretical and practical knowledge on large language models, prompt engineering techniques, and agents. They will learn to use frameworks like LangGraph and AutoGen for the design and implementation of the learned concepts in practical use cases. (MK2, MF3, MF4, MKO3)
	Personal competence: • Project organization skills • Presentation skills • Teamwork skills • Python programming skills

	(MKO1, MKO2, MF2)
Media	Slide sets, software, datasets
Literature	• Zhou et al.: A Comprehensive Survey on Pretrained Foundation Models: A History from BERT to ChatGPT, 2024, International Journal of Machine Learning and Cybernetics. • Zhao et al.: A Survey of Large Language Models, 2024, arXiv:2303.18223. • Wang et al.: A Survey on Large Language Model Based Autonomous Agents, 2024, Frontiers of Computer Science.
Methods	The course participants gain knowledge about the principles and methods behind large language models through lectures and tutorials. In the second half of the course, students apply their knowledge in team projects and will report about their results in the form of a written report as well as an oral presentation.
Form of assessment	Project report (70%), oral project presentation (30%)
Admission requirements for assessment	-
Duration of assessment	-
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Christian Bizer Ralph Peeters
Person in charge	Prof. Dr. Christian Bizer
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Mannheim Master in Social Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

IE 691	Information Retrieval Project
Form of module	Project
Type of module	Specialization course
Level	Master
ECTS	3
Workload	Hours per semester present: 28h (2SWS)
	Self-study: 60h per semester • Project work (45h) • Report and presentation preparation (15h)
Prerequisites	Programming skills (preferably in one of the higher-level programming languages: Java/Python/C#/C++).
Aim of module	Students are expected to successfully complete a team project in teams of 2-4 members. The projects will focus on a variety of IR problems and implementation of IR models theoretically covered in the course Information Retrieval and Web Search (IE 663). It is thus highly recommended to attend this course together with the course IE 663. Project deliverables include both software (i.e., code and documentation) and a short report explaining the work performed and its evaluation. The students are expected to clearly and coherently present the project results.
Learning outcomes and qualification goals	Expertise: Students will be able to solve real-world retrieval and search problems: they will be able to analyze different potential solutions to a given problem, identify their advantages and shortcomings, and decide for the best solution. (MK1, MF1)
	Methodological competence: Students will obtain skills needed to implement one or more information retrieval models and test their usefulness on real-world problems. Successful participants will be able to fully understand state-of-the-art methods for Information Retrieval and Web search, through hands-on experience of implementing those models. Students will also develop and/or improve their project organization skills (activity planning, work breakdown, time planning, etc.) (MK2, MF3, MF4, MKO3)
	Personal competence: • Presentation skills • Team work skills (MKO2, MF2)
Media	Project task specifications

Literature	• Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008. • B. Croft, D. Metzler, T. Strohman, Search Engines: Information Retrieval in Practice, Addison-Wesley, 2009 • R. Baeza-Yates, B. Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley, 2011 (2nd Edition).
Methods	Students work on implementing an information retrieval system in order to solve a real-world search problem. Students work in teams, implement the programmatic solutions to the tasks, organize their knowledge and results into a project report, and present the obtained results.
Form of assessment	Project report (70%, 10-20 pages in length), oral project presentation (30%, 20-30 minutes).
Admission requirements for assessment	-
Duration of assessment	4-6 weeks (execution of the project work and writing of the report), 20-30 minutes (presentation).
Language	English
Offering	HWS
Lecturer	Prof. Dr. Simone Ponzetto
Person in charge	Prof. Dr. Simone Ponzetto
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, Lehramt Informatik, MMDS, MMSDS
Semester	1st/2nd/3rd semester

IE 694	Artificial Intelligence Applications in Industry
Form of module	Lectures and accompanying Tutorials
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 h (2 + 2 SWS)
	Self-study: 124 h per semester Including the creation of a learning portfolio
Prerequisites	Necessary Knowledge: • Machine Learning Concepts and Techniques • Programming in Python
Aim of module	Participants will learn about the use of Artificial Intelligence methods, mostly from the field of machine learning in different sectors and industries. They will learn about application areas in the primary, secondary and tertiary sector, get an introduction to examples of such applications that have been published on a scientific level and gather some experience in working with data from the respective fields using publically available datasets.
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge about possible applications of machine learning in different branches of industry as well as the dominant methods used in these areas. (MK2, MK3)
	Methodological competence: Successful participants will be able to: • Identify potential for applying AI methods in different areas of industry; • Decide on a suitable method for addressing typical problems in these industries (MF2)
	Personal competence: Participants will learn to reflect and document their own learning process (MKO2)
Media	Slides, Data Sets, Software Tools.
Literature	Various Scientific Publications – details in the lecture slides
Methods	Lectures, tutorials, independent study
Form of assessment	Learning Portfolio
Admission requirements for assessment	n/a

Duration of assessment	Continuous assessment throughout the module (learning portfolio).
Language	English
Offering	FSS
Lecturer	Prof. Dr. Heiner Stuckenschmidt
Person in charge	Prof. Dr. Heiner Stuckenschmidt
Duration of module	1 Semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, Mannheim Master in Data Science, MMSDS
Semester	2.-4.

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 examination
Admission requirements for assessment	-
Duration of assessment	90 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

IE 696	Advanced Methods in Text Analytics
Form of module	Lecture with exercises
Type of module	Specialization course
Level	Master
ECTS	6
Workload	Hours per semester: 56 h (4 SWS)
	Self-study: 112 h per semester • 84 h: pre and post lecture studying and revision • 28 h: examination preparation
Prerequisites	Fundamental notions of linear algebra and probability theory. Successful completion of "Text Analytics" (IE661), "Machine Learning" (IE675b) or "Deep Learning" (IE678).
Aim of module	This module builds upon the introduction to Natural Language Processing (NLP) from "Text Analytics" (IE661) and introduces students to cutting-edge problems, techniques, and state-of-the-art methods in NLP. The course will focus on neural models of meaning in context and present a variety of "Deep Learning" architectures for different applications in human language technology (e.g., summarization, dialogue systems and machine translation). Moreover, we will cover open research areas, such as the explainability and interpretability of NLP models and methods to quantify the degree of bias they exhibit.
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge of state-of-the-art principles and methods of Natural Language Processing, specifically focusing on applying statistical methods to human language technologies. (MK1, MK2, MF3)
	Methodological competence: Successful participants will be able to understand state-of-the-art methods for Natural Language Processing and select, apply and evaluate the most appropriate techniques for various practical and application-oriented scenarios. (MF3)
Media	Lecture and tutorial slides, exercise sheets
Literature	Dan Jurafsky and James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition (3rd edition, online available at https://web.stanford.edu/~jurafsky/slp3/).
Methods	Lectures, tutorials
Form of assessment	Written examination
Admission requirements for assessment	-

Duration of assessment	90 minutes
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Simone Paolo Ponzetto
Person in charge	Prof. Dr. Simone Paolo Ponzetto
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, MMDS, MMSDS, Lehramt Informatik
Semester	1st/2nd/3rd semester

IE 698	Foundations and Applications of Digital Health Technologies
Form of module	Lecture
Type of module	Specialization Course
Level	Master
ECTS	3
Workload	Hours per semester in presence: 28 h per semester Self-study: 56 h per semester
Prerequisites	Necessary: Basic knowledge about AI systems (knowledge-based systems, machine learning, deep neural networks) Optional: • Participation of Lecture "Responsible AI" Winter Term 2023/24 • Basic knowledge about digital health systems
Aim of module	Conceptual foundations: • Understanding of important concepts in digital health (eHealth, mHealth, telehealth, digital phenotyping, digital twins, and other concepts) Methods: • e.g., interviewing, group discussions, design research methods (prototyping, design thinking, co-design), (digital) ethnography Applications: • AI in digital health apps in medicine and healthcare • AI-based robots • AI-based VR systems
Learning outcomes and qualification goals	Knowledge: Students gain insights and understanding of important concepts in digital health. They learn modes of transdisciplinary thinking and theorizing on digital health. (MK1)
	Capabilities: Students learn elements of mixed-methods study design for digital health research and co-design methodology and learn to assess scientific publications in this domain critically. (MF1 and MF2)
	Competencies: Students learn to critically assess the conceptual, technical, ethical, legal, and social aspects of digital health applications. (MKO1)
Media	Slides and supporting media will be available online.

Literature	• Fagherazzi, G. Deep Digital Phenotyping and Digital Twins for Precision Health: Time to Dig Deeper. Journal of Medical Internet Research 22, e16770 (2020). https://www.jmir.org/2020/3/e16770/
	• Hahn, H. & Schreiber, A. E-Health. in Digital Transformation (ed. Neugebauer, R.) 311–334 (Springer Berlin Heidelberg, 2019). https://doi.org/10.1007/978-3-662-58134-6_19
	• Budd, J. et al. Digital technologies in the public-health response to COVID-19. Nat Med 26, 1183–1192 (2020). https://www.nature.com/articles/s41591-020-1011-4
	• Voeneky, S., P. Kellmeyer, O. Mueller, and W. Burgard, ed. 2022. The Cambridge Handbook of Responsible Artificial Intelligence: Interdisciplinary Perspectives. Cambridge Law Handbooks. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781009207898 (open source)
Methods	Interactive lecture
Form of assessment	Written exam
Admission requirements for assessment	-
Duration of assessment	45 min
Language	English
Offering	Spring semester
Lecturer	Jun.-Prof. Dr. Philipp Kellmeyer
Person in charge	Jun.Prof. Dr. Philipp Kellmeyer
Duration of module	1 Semester
Further modules	Lecture on Responsible AI, Fall 2024
Range of application	Msc Business Informatics, Msc Data Science, Lehramt Informatik
Semester	All semesters possible

IE 699	Co-creating digital health applications with design methodology
Form of module	Excercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester in presence: 56 h Self-study: 112 h
Prerequisites	Necessary: Basic knowledge about AI systems (knowledge-based systems, machine learning, deep neural networks) Optional: • Participation of Lecture "Responsible AI" Winter Term 2023/24 • Basic knowledge about digital health systems
Aim of module	Conceptual foundations: Understanding of important concepts in digital health (eHealth, mHealth, telehealth, digital phenotyping, digital twins, and other concepts) Methods: Interviewing, group discussions, design research methods (prototyping, design thinking, co-design), (digital) ethnography Applications: By-design approaches to developing digital health apps and other solutions.
Learning outcomes and qualification goals	Knowledge: Along with digital health use cases, they learn basic by-design principles for developing digital health applications. (MK1)
	Capabilities: Students learn elements of mixed-methods study design for digital health research and co-design methodology via design fictions and mockups developed in groups in the exercise. (MF1, MF2, MF3)
	Competencies: Students learn to apply their knowledge and capabilities regarding by-design approaches to solve specific problems in a team context. (MKO1)
Media	Slides and supporting media will be available online.
Literature	• Fagherazzi, G. Deep Digital Phenotyping and Digital Twins for Precision Health: Time to Dig Deeper. Journal of Medical Internet Research 22, e16770 (2020). https://www.jmir.org/2020/3/e16770/ • Hahn, H. & Schreiber, A. E-Health. in Digital Transformation (ed. Neugebauer, R.) 311–334 (Springer Berlin Heidelberg, 2019). https://doi.org/10.1007/978-3-662-58134-6_19

	• Budd, J. et al. Digital technologies in the public-health response to COVID-19. Nat Med 26, 1183–1192 (2020). https://www.nature.com/articles/s41591-020-1011-4
	• Voeneky, S., P. Kellmeyer, O. Mueller, and W. Burgard, ed. 2022. The Cambridge Handbook of Responsible Artificial Intelligence: Interdisciplinary Perspectives. Cambridge Law Handbooks. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781009207898 (open source)
Methods	Excercise
Form of assessment	Presentation in course
Admission requirements for assessment	-
Duration of assessment	20 min (15 min. Presentation, 5 min Q&A)
Language	English
Offering	Spring semester
Lecturer	Jun.-Prof. Dr. Philipp Kellmeyer
Person in charge	Jun.Prof. Dr. Philipp Kellmeyer
Duration of module	1 Semester
Further modules	Lecture on Responsible AI, Fall 2024
Range of application	Msc Business Informatics, Msc Data Science, Lehramt Informatik
Semester	All semesters possible

iii. IS-Courses

Please check the course list on page 26.

For a detailed description please refer to the module catalog of the „Mannheim Master in Management ": https://www.bwl.uni-mannheim.de/modulkatalog-mmm/

iv. International Courses & other Specialization Courses

BI 656	International Course
Form of module	Depends on course taken abroad
Type of module	Specialization course
Level	Master
ECTS	Max. 18
Workload	Depends on course taken abroad
Prerequisites	Depends on course taken abroad
Aim of module	The course level equals a regular 600-level course in the MSc. Business Informatics program. The module can be taken during a study abroad term / semester and complements the Mannheim curriculum of the student.
Learning outcomes and qualification goals	Depends on course taken abroad
Media / Literature / Methods / Form and duration of assessment	Depends on course taken abroad
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	M.Sc. Wirtschaftsinformatik
Semester	2nd/3rd/4th semester

DS 203	Responsible AI: Conceptual Foundations, Methods and Applications
Form of module	Lecture with Essay
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester in presence: 28 (2 SWS) Self-study: 56 h lectures; 20 h essay / preparation oral exam
Prerequisites	Basic knowledge about AI systems (knowledge-based systems, machine learning, deep neural networks)
Aim of module	Conceptual foundations: • understanding of important concepts in human-AI interaction and AI ethics (such as trust, autonomy, responsibility) Methods: • e.g., narrative interviews, group discussions, design research methods (prototyping, design thinking, techno-mimesis), (digital) ethnography, participatory action research Applications: • AI in medicine and healthcare • Social robotics • Generative AI • other use cases / real-world AI applications
Learning outcomes and qualification goals	Expertise: Students gain insights and understanding of important concepts in human-AI interaction and AI ethics. They learn modes of transdisciplinary thinking and theorizing. Along sector-specific use cases they learn about ethical, legal and social aspects and challenges of real-world AI application, e.g. for healthcare.
	Methodological competence: Students learn elements of mixed-methods study design for human-AI interaction research
	Personal competence: Students learn to critically assess conceptual, ethical, legal and social aspects of human-AI interaction. They gain skills in transdisciplinary research and theory-building and learn to transfer these insights to real-world human-AI interaction scenarios.
Media	Slides are available online
Literature	• Voeneky, S., P. Kellmeyer, O. Mueller, and W. Burgard, ed. 2022. The Cambridge Handbook of Responsible Artificial Intelligence: Interdisciplinary Perspectives. Cambridge Law Handbooks. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781009207898 (open source)

	• Coeckelbergh, Mark. AI ethics. (2020). The MIT Press. https://www.gbv.de/dms/bowker/toc/9780262538190.pdf • Heilinger, J.-C. (2022). The Ethics of AI Ethics. A Constructive Critique. Philosophy & Technology, 35(3), 61. https://doi.org/10.1007/s13347-022-00557-9 • McLennan, S., Fiske, A., Tigard, D., Müller, R., Haddadin, S., & Buyx, A. (2022). Embedded ethics: A proposal for integrating ethics into the development of medical AI. BMC Medical Ethics, 23(1), 6. https://doi.org/10.1186/s12910-022-00746-3 • Schmitt, L. (2021). Mapping global AI governance: A nascent regime in a fragmented landscape. AI and Ethics. https://doi.org/10.1007/s43681-021-00083-y
Methods	Interactive lecture
Form of assessment	Essay
Admission requirements for assessment	--
Duration of assessment	Essays need to be handed in by December 8th
Language	English
Offering	Fall semester
Lecturer	JProf. Dr. Philipp Kellmeyer
Person in charge	JProf. Dr. Philipp Kellmeyer
Duration of module	1 Semester
Further modules	Follow-up (block) seminar planned for summer semester 2024
Range of application	Msc Business Informatics, Msc Data Science, Lehramt Informatik
Semester	All semesters possible

MAB 519	Reinforcement Learning
Form of module	Lecture with exercise classes
Type of module	Mathematics elective
Level	Master
ECTS	10
Workload	Lectures: 56h Exercise classes: 28h Self-study: 156h
Prerequisites	Stochastik I, Markovketten
Aim of module	• Foundations of Markov Decision Processes • Policy- and Value-Iteration Methods • Temporal Difference Learning • Policy-Gradient Methods • Implementation in Python
Learning outcomes and qualification goals	MK1, M02, M03
	MF1, MF3
	(cf, "Erläuterungen zu den Abkürzungen")
Media	Blackboard, Slides
Literature	• Lectures Notes • Sutton, Barto: Reinforcement Learning - An Introduction • Putterman: Markov Decision Processes
Methods	Lectures, theoretical and programming exercises
Form of assessment	Oral exam
Admission requirements for assessment	Participation in the exercises
Duration of assessment	30 minutes
Language	English
Offering	Irregular
Lecturer	Prof. Dr. Leif Döring
Person in charge	Prof. Dr. Leif Döring
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsmathematik, B.Sc. Wirtschaftsmathematik, M.Sc. Mathematik, M.Sc. Mannheim Master in Data Science, M.Sc. Wirtschaftsinformatik
Semester	1./2./3. semester

MAC 404	**Lineare Optimierung**
	Linear Optimization
Form der Veranstaltung	Vorlesung mit Übung
Typ der Veranstaltung	Wahlpflichtveranstaltung Mathematik
Modulniveau	Bachelor
ECTS	8
Arbeitsaufwand	Präsenzstudium: 84 h pro Semester (6 SWS)
	Eigenstudium: 154 h pro Semester
	• davon Vor- und Nachbereitung der Veranstaltung und freies Selbststudium: 126 h pro Semester
	• davon Vorbereitung für die Prüfung: 28 h pro Semester
Vorausgesetzte Kenntnisse	Lineare Algebra I und IIA, Analysis I und II
Lehrinhalte	• Geometrie von Polyeder
	• Theorie der Linearen Optimierung
	• Ganzzahlige Optimierung
	• Innere Punkt Verfahren
	• Optimierung auf Graphen
Lern- und Kompetenzziele	Fachkompetenz:
	• Verständnis der wesentlichen Konzepte und Lösungsverfahren der Linearen Optimierung (BF1, BK1)
	• Computerunterstütze Umsetzung anwendungsbezogener Fragestellungen (BK2, BK3, BO1)
	• Querverbindungen zu anderen mathematischen Gebieten identifizierten Klassifikation und Interpretation numerischer Probleme (BK1, BO2)
	Methodenkompetenz:
	• Mathematische Modellierung eines Problems (BF3, BO3)
	• Konkrete Problemlösungsstrategien und deren Interpretation (BF1, BF2)
	Personale Kompetenz:
	• Teamarbeit (BO1, BF4, BF5)
Medienformen	Präsentationen mit Tafelanschriebe, Eigenes Skriptum
Begleitende Literatur	• Robert J. Vanderbei, Linear Programming: Foundations and Extensions
	• Alexander Schrijver: Theory of linear and integer programming
	• Michele Conforti, Gerard Cornuejols, Giacomo Zambelli: Integer Programming
Lehr- und Lernmethoden	Vorlesung (4 SWS), Übung (2 SWS),
Art der Prüfungsleistung	Schriftliche Prüfung

Prüfungsvorleistung	Bearbeitung von Übungsblättern und mindestens 50% der Übungsaufgaben bestanden
Prüfungsdauer	90 Minuten
Sprache	Deutsch, auf Wunsch auch Englisch
Angebotsturnus	HWS
Lehrende/r	Prof. Mathias Staudigl PhD
Modulverantwortliche	Prof. Mathias Staudigl PhD
Dauer des Moduls	1 Semester
Weiterführende Module	Nonlinear Optimization, Konvexe Optimierung, Optimale Kontrolle
Verwendbarkeit	B.Sc. Wirtschaftsmathematik, M.Sc. Wirtschaftsmathematik, M.Sc. Wirtschaftspädagogik, Lehramt Mathematik, B.Sc. Wirtschaftsinformatik, M.Sc. Wirtschaftsinformatik
Einordnung in Fachsemester	5./6. Fachsemester

MAC 570	Reinforcement Learning - Coding
Form of module	Lectures with exercises
Type of module	Mathematics elective
Level	Master
ECTS	5
Workload	28 hours lectures 122 hours self-studies
Prerequisites	Reinforcement Learning
Aim of module	• Implementation of standard algorithms in reinforcement learning • Bandit algorithms (UCB) • TD algorithms (Q-learning, TD) • Policy gradient algorithms (SAC, PPO)
Learning outcomes and qualification goals	MK1, M02, M03
	MF1, MF3
	(cf, "Erläuterungen zu den Abkürzungen")
Media	Blackboard, Slides
Literature	Original articles
Methods	Lectures, programmig tasks
Form of assessment	Written exam
Admission requirements for assessment	-
Duration of assessment	90 minutes
Language	English
Offering	Irregular
Lecturer	Prof. Dr. Leif Döring, Prof. Dr. Simon Weißmann
Person in charge	Prof. Dr. Leif Döring, Prof. Dr. Simon Weißmann
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsmathematik, M.Sc. Mathematik, M.Sc. Mannheim Master in Data Science, M.Sc. Wirtschaftsinformatik
Semester	1./2./3. semester

2. Detailed Descriptions

i. Team Project

TP 500	Team Project
Form of module	Project
Type of module	Team Project
Level	Master
ECTS	12 in two consecutive semesters or 12 in one semester
Workload	Hours per semester: 12 month-project: 28 h (2 SWS) 6 month-project: 56 h (4 SWS) Self-study: 140 h per semester (12 month project); • 112 h: pre and post lecture studying, revision and free self-study • 28 h: preparation of examination/presentation Self-study: 280 h per semester (6 month project) • 224 h: pre and post lecture studying, revision and free self-study • 56 h: preparation of examination/presentation
Prerequisites	Depends on topic
Aim of module	The students solve a practical problem as a team. The participants have to analyze and refine the problem and come up with a project plan for developing a concrete solution that will be carried out by the team over the duration of a whole year. Concrete topics for projects are defined by the supervisors and offered to the students who can apply for different topics. Problem area and techniques involved depend on the expertise of the offering chair.
Learning outcomes and qualification goals	Depending on the actual topic of the project, participants will acquire • in depths knowledge in a certain application of business informatics and data science • knowledge about methods and technologies typically applied in the application area • knowledge about practical problems and challenges when applying a certain technique in a given application area (MK1, MK2, MK3) Participants will learn to • refine a given problem statement by analyzing requirements and the state of the art using techniques like literature research and expert interviews.

	• Define a workplan including tasks, milestones, deliverables and resources and continually assess and modify the plan according to the actual progress of the work. (MF1, MF2, MF3, MF4)
	Being a team effort, the project explicitly targets personal competence in terms of • working in and managing a team of experts possibly from different academic and cultural backgrounds • taking part in discussions and learning to contribute the own opinion without overruling other opinions • self-management and responsibility within the requirements of collaborative work (MKO1, MKO2, MKO3)
Media	Depends on project
Literature	Depends on topic
Methods	Team-discussions, Presentations, Teamwork, Individual preparation of empirical contributions; self-study
Form of assessment	One or more reports totaling 50 - 120 pages (depending on the topic) and presentation (10-90 minutes).
Admission requirements for assessment	• 12-month project: withdrawal within the first 6 weeks possible without failing • 6-month project: withdrawal within the first 3 weeks possible without failing
Duration of assessment	Final report (length: one of more reports totalling 50-120 pages depending on the topic), presentation (10-90 minutes depending on the topic).
Language	English
Offering	Spring semester/Fall semester
Lecturer	Professors of the Institute of Computer Science and Business Informatics or of the Area Information Systems of the Business School
Person in charge	Professors of the Institute of Computer Science and Business Informatics or of the Area Information Systems of the Business School
Duration of module	1 semester or 2 semesters
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	1st/2nd/3rd semester

ii.   Scientific Research

SQ 500	Scientific Research
Form of module	Inverted Classroom with Exercises
Type of module	Key Qualification
Level	Master
ECTS	2
Workload	80% (48 hours) self-study and 20% (12 hours) coursework
Prerequisites	None
Aim of module	This course focuses on the basic key competences that are needed to successfully write a scientific paper or a thesis. It is recommended that you take this module before you participate in a seminar. Topics include: • Scientific process and scientific writing • Bibliographic research methodology • Search strategies in bibliographic databases • Finding data for your research • How to read, understand and cite scientific literature • Reference management systems and LaTeX
Learning outcomes and qualification goals	Expertise: The students understand how to work scientifically and how to write a thesis.
	Methodological competence: The students can find relevant publications for a research question.
	Personal competence: • Everybody wrote a short overview of his/her research question. • Everybody installed and used exemplary tools to support the work process
Literature	• The craft of research / Wayne C. Booth; Gregory G. Colomb; Joseph M. Williams (Chicago guides to writing, editing, and publishing); 3. ed.; Chicago, Ill. ; [u.a.] : University of Chicago Press, 2008 ; XVII, 317 S. : graph. Darst. ; 22cm. • LaTeX (Wikibook): http://en.wikibooks.org/wiki/LaTeX
Methods	The students can individually work through the video recordings of the lecture and do the accompanying hands-on exercises. The live sessions will be held online as well and are mainly dedicated to clarifying any questions from the students.
Form of assessment	Eine digital unterstützte Hausarbeit

Admission requirements for assessment	Successful participation in at least 60% of all online exercises
Duration of assessment	150 minutes
Language	English
Offering	Spring semester/Fall semester
Lecturer	Lecturer from the University Library (UB)
Person in charge	Lecturer from the University Library (UB)
Duration of module	1 Semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, MMDS
Semester	1st/2nd/3rd semester

CS 701	Selected Topics in Algorithmics and Cryptography
Form of module	Seminar
Type of module	Seminar
Level	Master
ECTS	4
Workload	120 h per Semester
Prerequisites	Algorithmics (CS 550) or Cryptography II (CS 651) or Courses in Algorithms or Cryptography or Theoretical Computer Science or Complexity Security at Bsc or Msc Level, key qualification scientific research.
Aim of module	The students prepare a scientific report on a current research topic on the basis of published papers under guidance of a scientific staff member and gives a presentation. The topic will be proposed by the professor, but the students may also propose topics. Active participation in the seminar presentations of fellow students will be expected.
Learning outcomes and qualification goals	Expertise: The students gain a deep understanding of the research topic, are able to explain the topic in detail in a clean and transparent ways and are able to classify the significance of the topic and the results in relation to the current state of research in the corresponding research area.
	Methodological competence The students are able to read, to understand and to explore scientific literature relevant to the topic. They are aware of the need to avoid plagiarism.
	Personal competence: The student has learned how to find relevant literature for a research topic, write a well-structured and clear report about it and give a presentation. The seminar serves also as preparation for writing and presenting the master thesis.
Media	Scientific papers and books. Presentation systems like PowerPoint or beamer Latex.
Literature	Depends on the topic.
Methods	Do scientific work independently under the guidance of a research staff member and manage an active discussion on the topic in a group of peers.
Form of assessment	Presentation and discussion (15-60 minutes), Written essay/report (5-25 pages), Participation.

Admission requirements for assessment	Timely hand-in of seminar papers and presentation materials
Duration of assessment	60 minutes presentation with 15-30 minutes discussion; written report (length: 15 pages).
Language	English
Offering	Spring
Lecturer	Matthias Krause
Person in charge	Prof. Dr. Matthias Krause
Duration of module	1 Semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, M.Sc. Wirtschaftsmathematik
Semester	3rd semester

CS 704	Master Seminar Artificial Intelligence
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Decision Support or Data Mining or Knowledge Management
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	Expertise: The student gains a deep understanding of the research topic. He/she is able to describe/summarize the topic in detail in his/her own words. He/she reflects on the topic and judges the contribution of the research papers. (MK1, MK2, MK3)
	Methodological competence: The student is able to write a well-structured scientific paper and to present his/her results. He/she is also aware of the need to avoid plagiarism. The key qualification Scientific Research is highly recommended as a prerequisite for the seminar. (MF2)
	Personal qualification: 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. (MF2)
Media	Scientific papers and books; final presentation with latex slides
Literature	Depends on the topic of the seminar
Teaching and Learning Methods	Do scientific reading independently under the guidance of a professor or a research staff member. Active discussions in a group of peers.

Form of Assessment	We offer two types of seminars: Seminar with a focus on theory and literature: Two presentations (30 minutes overall) and a final seminar report (15-20 pages). Practical Seminar: Two presentations (30 minutes overall) and a final seminar report (12-15 pages) presenting own results. Offered in exceptional cases as group work. In such cases, the practical task is more extensive/challenging. Code has to be submitted in addition to the final report. More about content and type of the seminar can be found at https://www.uni-mannheim.de/dws/teaching/course-details/courses-for-master-candidates/
Admission requirements for assessment	-
Duration of Assessment	Both presentations must be given within a span of 5-10 weeks, the final report has to be submitted after this period
Language	English
Offering	Irregular
Lecturers	Prof. Dr. Heiner Stuckenschmidt
Person in charge	Prof. Dr. Heiner Stuckenschmidt
Duration of module	1 semester
Further modules	-
Range of Application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	3rd semester

CS 707	Data Analytics Seminar
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	CS Fundamentals; relevant Master Courses depending on the topic
Aim of module	The student prepares a scientific report and gives at least one presentation on a current research topic based on published research papers. The topics lie in the area of Data and Web Science and are proposed by the professor or the student. Report and presentations are prepared under the guidance of a professor or a research staff member. The student may also moderate a discussion of a presentation of a fellow student, act as a peer reviewer for the presentations or reports of other students, or experiment with a data analysis system. Active participation in the seminar discussions is expected.
Learning Outcomes and Qualification Goals	Expertise: The student gains a deep understanding of the research topic. He/she is able to describe/summarize the topic in detail in his/her own words. He/she reflects on the topic and judges the contributions of the research papers.
	Methodological competence: The student is able to read, understand, and explore scientific literature relevant to his/her topic. He/she is also aware of the need to avoid plagiarism. The key qualification Scientific Research is recommended as a prerequisite for this seminar.
	Personal qualification: The student has learned how to find relevant literature for a research topic, write a well-structured, concise report about it and give presentations. He/she will be well prepared to write and present a Bachelor's/Master's Thesis.
Media	Scientific papers and books; software and datasets; final presentation
Literature	Depends on the topic of 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	Flash presentation (3 minutes), Final presentation (15 minutes presentation + discussion + moderation), Report (10 pages + references/appendix), Peer review, Optionally: code hand-in

Admission requirements for assessment	-
Duration of Assessment	N/A
Language	English
Offering	F SS + HWS (typically)
Lecturers	Prof. Dr. Rainer Gemulla or research staff member
Person in charge	Prof. Dr. Rainer Gemulla or research staff member
Duration of module	1 semester
Further modules	-
Range of Application	M.Sc. Wirtschaftsinformatik, MSc. Mannheim Master in Data Science, Lehramt für Gymnasien
Semester	3rd semester

CS 708	Seminar Software Engineering
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Bachelor's degree, the fundamentals
Aim of module	Student prepares a scientific paper and gives a presentation on a current software engineering research topic based on published research papers. State-of-the-art topics are proposed by the software engineering group. Active participation in the seminar discussions is expected.
Learning Outcomes and Qualification Goals	Expertise: 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 papers. Methodological competence: The student is able to find the relevant literature for their topic, 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. Personal qualification: The student has learned how to find relevant literature for a research topic, write a well-structured, concise paper about it and give a presentation.
Media	Scientific papers and books, presentation
Literature	Depends on the topic of the seminar
Teaching and Learning Methods	Scientific work performed independently under the guidance of a member of the software engineering group.
Form of Assessment	• Seminar paper (final report): 12-13 pages excluding references • Presentation (15 minutes) plus discussion (5 - 10 minutes) • Peer review: 1-5 pages • Accompanying work products (e.g., code, models, spreadsheets, documents etc.)
Duration of Assessment	Presentation (15 minutes) plus discussion (5 – 10) minutes
Language	English
Offering	Irregular
Lecturer	Colin Atkinson
Duration of module	1 semester

Range of Application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science,
Semester	1./ 2. /3. Semester

CS 709	Seminar Text Analytics
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	IS 661 "Text Analytics" or IE 663 "Web Search and Information Retrieval" or IE 696 "Advanced Text Analytics". Fundamental notions of linear algebra and probability theory.
Aim of module	In this seminar, students write a survey/scientific paper and provide an overview presentation of state-of-the-art research, as found within the existing literature (i.e., published research papers). Topics of interest focus around a variety of problems and tasks from the fields of Natural Language Processing and Information Retrieval. The paper and the presentation are prepared under the guidance of a professor or a research staff member.
Learning Outcomes and Qualification Goals	Expertise: Students will acquire a deep understanding of the research topic. They are expected to describe in-depth and summarize the topic in detail in their own words, as well as to judge the contribution of the research papers to ongoing research.
	Methodological competence: Students will develop methods and skills to find relevant literature for their topic, to write a well-structured survey/scientific paper and to present their results. They will be also aware of the need to avoid plagiarism. The key qualification Scientific Research is highly recommended as a prerequisite for the seminar.
	Personal qualification: Students will acquire skills on how to find relevant literature for a research topic, write a well-structured, concise paper about it and present the results of their work. They are well prepared to write and present a Master's Thesis.
Media	Scientific papers and books; presentation with PowerPoint or LaTeX.
Literature	Depends on the topic of 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	Flash presentation (3 minutes), Final presentation (15 minutes presentation + discussion + moderation), Report (10 pages + references/appendix), Peer review, Optionally: code hand-in

Admission requirements for assessment	-
Duration of Assessment	
Language	English or German
Offering	Irregular
Lecturers	Prof. Dr. Simone Paolo Ponzetto
Person in charge	Prof. Dr. Simone Paolo Ponzetto
Duration of module	1 semester
Further modules	-
Range of Application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	3rd semester

CS 710	Selected Topics in Data Science
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Bachelor degree, the fundamentals
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 Mining, Web Mining, or the Semantic Web.
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, as well as to judge the contribution of the research papers to ongoing research. (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. (MF2) 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. (MF2)
Media	Scientific papers and books
Literature	Depends on the topic of the seminar
Teaching and Learning Methods	Do scientific work independently under the guidance of a professor or a research staff member
Form of Assessment	Seminar paper (length: 5-25 pages depending on the topic), Peer Review (1-10 pages depending on the topic), Presentation (15-60 minutes depending on the topic).

Admission requirements for assessment	-
Duration of Assessment	6-8 weeks (writing of the essay), 15-60 minutes (presentation).
Language	English or German
Offering	Irregular
Lecturers	Prof. Dr. Heiko Paulheim and research staff members
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, Lehramt für Gymnasien
Semester	3rd semester

CS 715	Solving Complex Tasks using Large Language Models
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Bachelor's degree, the fundamentals
Aim of module	The seminar explores prompt engineering, fine-tuning, as well as agent-based techniques for enabling LLMs to handle complex tasks as well as using LLMs to evaluate complex outputs. The seminar features literature as well as experimental topics. The goal of the literature topics is to summarize the state of the art concerning the application and evaluation of LLMs for a specific task. The goal of the experimental topics is to verify the utility of advanced techniques by applying them to tasks beyond the tasks used in the original papers.
Learning Outcomes and Qualification Goals	Expertise: Students will acquire a deep understanding of the state of the art with respect to their research topic. They learn to summarize the state of the art, judge methods along different criteria, design experiments, and present experimental results. Methodological competence: Students will develop methods and skills to find relevant literature for their topic, to prepare methodologically sound scientific experiments, and to write a well-structured scientific paper and to present their results. They will be also aware of the need to avoid plagiarism. The key qualification Scientific Research is highly recommended as a prerequisite for the seminar. 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.
Media	Scientific papers and books
Literature	Depends on the specific topic
Teaching and Learning Methods	Perform scientific work independently under the guidance of a professor or a research staff member
Form of Assessment	Report (12 - 15 pages excluding references) Presentation (12 minutes + 8 minutes discussion)
Admission requirements for assessment	-
Duration of Assessment	6-8 weeks (writing of the seminar paper)

Language	English
Offering	Irregular
Lecturers	Prof. Dr. Christian Bizer and research staff members
Person in charge	Prof. Dr. Christian Bizer
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 für Gymnasien
Semester	3rd semester

CS 716	IT-Security
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Bachelor's degree, the fundamentals
Aim of module	The student gives a presentation on a current research topic based on published research papers. The topics are proposed by the professor (but the student may also propose topics). The presentation is prepared under the guidance of a professor or a research staff member. The student may also moderate a discussion of a presentation of a fellow student or act as a peer reviewer for the presentations or reports of other students. Active participation in the seminar discussions is expected.
Learning Outcomes and Qualification Goals	Expertise: 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 contributions of the research papers. Methodological competence: The student is able to read, understand, and explore scientific literature relevant to their topic. They are also aware of the need to avoid plagiarism. The key qualification Scientific Research is recommended as a prerequisite for this seminar. Personal qualification: The student has learned how to find relevant literature for a research topic, write a well-structured, concise report about it and give a presentation. They will be well prepared to write and present a Bachelor's/Master's Thesis.
Media	Scientific papers and books; final presentation with PowerPoint or similar software
Literature	Depends on the topic of 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	Grading of the oral presentation and the seminar paper.
Admission requirements for assessment	Timely hand-in of seminar paper and presentation
Duration of Assessment	45 minutes talk, 45 minutes discussion, seminar paper (8 sites, double columns)
Language	English

Offering	Irregular
Lecturers	Prof. Dr. Armknecht
Person in charge	Prof. Dr. Armknecht
Duration of module	1 semester
Further modules	-
Range of Application	M.Sc. Wirtschaftsinformatik, Lehramt für Gymnasien, M.Sc. Wirtschaftsmathematik
Semester	3rd Semester

CS 717	Master Seminar on Computer Vision
Form of module	Seminar
Type of module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Higher Level Computer Vision, Generative Computer Vision Models, or Image Processing
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	Expertise: The student gains a deep understanding of the research topic. He/she is able to describe/summarize the topic in detail in his/her own words. He/she reflects on the topic and judges the contribution of the research papers. Methodological competence: The student is able to write a well-structured scientific paper and to present his/her results. He/she is also aware of the need to avoid plagiarism. The key qualification Scientific Research is highly recommended as a prerequisite for the seminar. Personal qualification: 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 Literature	Scientific papers and books Depending on the topic of the seminar
Methods	Do scientific reading independently under the guidance of a professor or a research staff member. Active discussions in a group of peers.
Form of assessment	50% Presentations (one 3-5min presentation and one 25-30min presentation) 50% Seminar Report (10-20 pages, has to be submitted after three months)
Admission requirements for assessment	none
Duration of assessment	N/A
Language	English

Offering	HWS/FSS
Lecturer	Margret Keuper
Person in charge	Margret Keuper
Duration of module	1 Semester
Further modules	
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	3rd Semester

CS 718	AI and Data Science in Fiction and Society
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Bachelor degree
Aim of module	In this seminar, students analyze and discuss fictional works in the area of AI and data science with respect to technological and societal aspects. The present the results orally and in a written report.
Learning Outcomes and Qualification Goals	Expertise: Students will learn about societal effects of AI and data science and become aware of potential threats and dangers, but also of chances of those new technologies. (MK1) Methodological competence: Students will develop methods and skills to find relevant literature for his/her topic, 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, discuss a fictional work using secondary literature as background material, 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. (MKO2)
Media	Fictional and non-fictional texts
Literature	A detailed literature list is compiled for each offering.
Teaching and Learning Methods	Do scientific work independently under the guidance of a professor or a research staff member
Form of Assessment	Seminar paper (length: 15-20 pages depending on the topic), Peer Review (up to 10 pages), Presentation (20-30) minutes depending on the topic)
Admission requirements for assessment	-
Duration of Assessment	6-8 weeks (writing of the essay), 20-30 minutes (presentation).
Language	English

Offering	Fall semester
Lecturers	Prof. Dr. Heiko Paulheim and research staff members
Person in charge	Prof. Dr. Heiko Paulheim
Duration of module	1 semester
Further modules	-
Range of Application	MMDS, M. Sc. Wirtschaftsinformatik, Lehramt für Gymnasien
Semester	3. Semester

CS 720	Uncertainty Estimation
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Bachelor degree, the fundamentals
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 Mining, Web Mining, or the Semantic Web.
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, as well as to judge the contribution of the research papers to ongoing research. (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. (MF2)
	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. (MF2)
Media	Scientific papers and books
Literature	Depends on the topic of the seminar
Teaching and Learning Methods	Do scientific work independently under the guidance of a professor or a research staff member
Form of Assessment	Seminar paper (length: 5-25 pages depending on the topic), Peer Review (1-10 pages depending on the topic), Presentation (15-60 minutes depending on the topic).
Admission requirements for assessment	-

Duration of Assessment	6-8 weeks (writing of the report), 15-60 minutes (presentation).
Language	English or German
Offering	Irregular
Lecturers	Tobias Weller
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, Lehramt für Gymnasien
Semester	3rd semester

CS 721	Seminar Data-Science I
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	There are no formal requirements. However, previous participation in the courses "Network Science" 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, 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	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, as well as to judge the contribution of the research papers to ongoing research. (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. (MF2)
	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. (MF2)
Media	slides, scientific papers, blackboard (electronic)
Literature	Depends on the topic.
Teaching and Learning Methods	Self-study of assigned material, presentation of scientific articles, joint discussion of work, collaboration with peers

Form of Assessment	• Preparation of a seminar report (12–14 pages, plus bibliography) • Presentation of the seminar paper and answering questions (40 minutes) • Participation in the presentation discussions • Reflection on a seminar report written by someone else
Admission requirements for assessment	
Duration of Assessment	
Language	English
Offering	Irregular
Lecturers	Markus Strohmaier, Marlene Lutz
Person in charge	Markus Strohmaier, Marlene Lutz
Duration of module	1 semester
Further modules	-
Range of Application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	3rd semester

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	Expertise: 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. Methodological competence: 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. Personal qualification: 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 731	Database Theory
Form of module	Seminar
Type of module	Seminar
Level	Master
ECTS	4
Workload	120h per semester
Prerequisites	Theoretical Computer Science, Complexity Theory, Decidability Theory, DBSI
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	Expertise: 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. Methodological competence: 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. Personal qualification: 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
Semester	2./3. Semester

IS 712	Contemporary Issues in Information Systems Research
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	Bachelor's degree, the fundamentals
Aim of module	The primary objective of the seminar is to analyze information systems development and use from different perspectives. The secondary objective is to provide students with techniques of scientific writing in a fascinating real-world setting. Important aspects are the evaluation, structuring, and classification of existing research work and the presentation of a detailed and thorough overview of the current state of the art. In addition, scientific work also includes the creation of new knowledge. The participation in the seminar can be regarded as an important preliminary step towards a successful completion of the final thesis.
Learning Outcomes and Qualification Goals	Expertise: The student gains a deep understanding of the research topic. They are able to conduct basic scientific research. They reflect on the topic and judges the contribution of the research papers.
	Methodological competence: The student is able to find the relevant literature for their topic, 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.
	Personal qualification: The student has learned how to find relevant literature for a research topic, write a well-structured, concise paper about it and give a presentation. They are well prepared to write and present a Master's Thesis.
Media	Scientific papers and books; final presentation with PowerPoint
Literature	Depends on the topic of 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	• Preparation of a seminar paper (15–25 pages written, plus bibliography) • Presentation of the seminar paper and answering questions (15-30 minutes)

	• Reflection on a seminar paper written by someone else (discussant statement; 2–5 minutes) • Participation in the plenary discussion
Admission requirements for assessment	-
Duration of Assessment	N/A
Language	English
Offering	Irregular
Lecturers	Prof. Dr. Armin Heinzl and research assistants
Person in charge	Dr. Monica Fallon
Duration of module	1 Semester
Further modules	-
Range of Application	Mannheim Master in Management, M.Sc. Business Informatics
Semester	3. Semester

E. Master Thesis

MA 650	Master Thesis
Form of module	Master Thesis
Type of module	Thesis
Level	Master
ECTS	30
Workload	Self-study: 840 h per semester
Prerequisites	The student is required to have obtained at least 60 ECTS credits in order to register for his or her master thesis
Aim of Modules	Develop a deep understand of an advanced topic of business informatics or computer science
Learing outcomes and qualifications goals	Expertise: The student has a deep understanding of an advanced topic. (MK1)
	Methodological competence: The student is familiar with methods for analysing and independently solving advanced, complex problems. (MK1, MK2, MK3)
	Personal competence: The student has the capability to understand, analyse and independently find solutions to advanced, complex problems. The student has the capability to assess and understand the state-of-the-art in business informatics and adapt the latest technologies and methods to solve real world problems. The student is able to present a complex topic in written and oral form in a clear and understandable way. (MF1, MF2, MF3, MF4, MKO2, MKO3)
Media	Various
Literature	Topic dependent
Methods	Independent research work
Form of Assessment	Written thesis, 10-120 pages in length depending on the topic.
Admission requirements for assessment	To be permitted to write the master thesis, the student is to obtain at least 60 ECTS
Duration of Assessment	6 months (execution of the thesis work and writing of the thesis manuscript).
Language	English or German
Offering	Every semester
Person in Charge	Professors of the Institute of Computer Science and Business Informatics or of the Area Information Systems of the Business School
Duration of module	1 semester
Further modules	-

Range of Applications	M.Sc. Wirtschaftsinformatik
Semester	4. Semester