2. Detailed descriptions

i. Fundamentals Computer Science

CS 500	Advanced Software Engineering
Form of module	Lectures and accompanying tutorials
Type of module	Computer Science Fundamental
Level	Master
ECTS	6
Workload	Hours per semester present: 56 h (4 SWS)
	Self-study: 112 h per semester • 28h: pre and post lecture studying and revision • 56h: tutorial exercises • 28h: directed independent study (reading papers, books etc.)
Prerequisites	-
Aim of module	The course deals with the model-based specification of software systems and components as well as their verification, validation and quality assurance. The emphasis is on view-based specification methods that use multiple views, expressed in multiple languages, to describe orthogonal aspects of software systems/components. Key examples include structural views represented using class diagrams, operational views expressed using constraint languages and behavioral views expressed using state diagrams. An important focus of the course is the use of these views to define tests and extra-functional properties.
Learning outcomes and qualification goals	Expertise: After taking the course, students will be familiar with the latest state-of-the-art techniques for specifying the externally visible properties of a software system/component – that is, for describing a software system/component as a "black box", and for verifying them. (MK1, MK2)
	Methodological competence: Participants will know how to use the expertise acquired during the course to describe the requirements that a system/component has to satisfy and to define tests to check whether a system/component fulfils these requirements. (MF1, MF3)
	Personal competence: With the acquired skills and know-how, students will be able to play a key role in projects involving the development of systems, components and software applications.

	(MKO3)
Media	Printed Lecture Notes, Presentations, Tool Demonstrations
Literature	• C. Atkinson et. al., Component-Based Product Line Engineering with the UML, Addison-Wesley, 2001. • Paul Ammann & Jeff Offutt., "Introduction to Software Testing", Cambridge University Press, January 2008.
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. Wirtschaftspädagogik, Lehramt Informatik
Semester	1./ 2. semester

CS 530	**Database Systems II (DBSII)**
Form of module	Lecture & exercises
Type of module	Computer Science Fundamental
Level	Master
ECTS	6
Workload	Hours per semester present: 2 + 2 per week
	Self-study: 4 per week
Prerequisites	DBS I, Computer Architecture, Algorithm & Datastructures, C++
Aim of module	Adanced database topics, e.g., distributed databases, main memory databases, data warehouses
Learning outcomes and qualification goals	Expertise: know about advanced database topics
	Methodological competence: learn how to program efficiently
	Personal competence: learn how to listen carefully
Media	Beamer + Blackboard
Literature	Kemper, Eickler: Datenbanksysteme
Methods	The course consists of a lecture accompanied by weekly homeworks. In the lecture the students will learn concepts which are then applied in the homework.
Form of assessment	Written exam
Admission requirements for assessment	-
Duration of assessment	90 min
Language	English
Offering	Spring semester
Lecturer	Guido Moerkotte
Person in charge	Guido Moerkotte
Duration of module	1 semester
Further modules	Query Optimization

Range of application	M.Sc. Wirtschaftsinformatik, MMDS
Semester	1st / 2nd semester

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 • discret 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, tro analyze their structure with the goal to design efficient algorithms, to prove the correctness and to

	analyze 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, MK03)
Media	Writing with chalk at the blackboard, slides and electronic media
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	Fall semester / 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
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	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	Very good knowledge of database systems, good knowledge of algorithms and data structures as well as 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 • Big data platforms • NoSQL, NewSQL and polystore systems
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge about methods and systems for managing large datasets and data-intensive computing. (MK1, MK2)
	Methodological competence: • Be able to judge, select, and use traditional or non-traditional data management systems for a given data management task • Be able to solve computational problems involving large datasets (MF1)
	Personal competence: • Study independently • Presentation and writing skills (MKO3)
Media	Slide set, black board, exercise sheets, datasets, software
Literature	• T. Öszu, 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 • L. Wiese *Advanced Data Management: For SQL, NOSQL, Cloud and Distributed Databases* De Gruyter, 2015 • T. White *Hadoop – The Definitive Guide* O'Reilly, 4th ed., 2015 • 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

IE 500	**Data Mining I**
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 • Clustering • Classification • Regression • Association Analysis • Text Mining • Systems and Applications (e. g. Retail, Finance, Web Analysis)
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 organisation skills (MK2, MF3, MF4, MKO1)
	Personal competence: • team work skills • presentation skills (MKO2, MF2)
Media	slide set, exercise sheets, data sets for the exercises

Literature	• Pang-Ning Tan, Michael Steinback, Vipin Kumar: Introduction to Data Mining, Pearson. • Vijay Kotu, Bala Deshpande: Predictive Analytics and Data Mining: Concepts and Practice with RapidMiner. Morgan Kaufmann Bing Liu: Web Data Mining, 2nd Edition, Springer.
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 team projects take place in the last third of the term. Within the projects, students realize more sophisticated 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)
Language	English
Offering	Fall semester / Spring semester
Lecturer	Prof. Dr. Heiko Paulheim; Prof. Dr. Christian Bizer
Person in charge	Prof. Dr. Heiko Paulheim; Prof. Dr. Christian Bizer
Duration of module	1 Semester
Further modules	IE 672 – Data Mining II, IE 671 – Web Mining, IE 661 – Text Analytics, IE 674 – Hot Topics in Machine Learning
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	$1^{st}/2^{nd}$ semester

IE 560	Decision Support
Form of module	Inverted classroom
Type of module	Business Informatics Fundamental
Level	Master
ECTS	6
Workload	Hours per semester: 28 h (2 SWS)
	Self-study per semester: 152 h • 96 h: pre- and post lecture studying and revision • 56 h: exam preparation
Prerequisites	Basic Probability Theory, Basic Knowledge of Propositional and First-Order Logic
Aim of module	The course provides an introduction to decision support techniques as a basis for the design of decision support systems. The course will cover the following topics: • Decision Theory • Decision- and Business Rules • Probabilistic Graphical Models • Game Theory and Mechanism Design
Learning outcomes and qualification goals	Expertise: Students will acquire basic knowledge of the techniques, opportunities and applications of decision theory. (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: -
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	-
Duration of assessment	Written examina: 45+45 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	Advanced Software Engineering
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, etc.) as well as leading edge, state-of-the-art modelling technologies (e. g. LML, PLM . . .). Key topics addressed include: • Multi-level modeling • Meta-modeling • Ontology engineering versus model engineering • Model transformations • Domain specific language definition and use • Model creation and evolution best practices • Model-driven software development • Model checking and ontology validation
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	1st/2nd/3rd semester

CS 605	**GPU Programming**
Form of module	Video Lecture (Inverted Classroom) with Virtual Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Self-study: 180 h per Semester
Prerequisites	Fundamental knowledge in • C/C++ • Algorithms and Data Structures
Aim of module	The module teaches basic concepts of GPUs and how to implement efficient parallel algorithms for them. In this lecture, we primarily use CUDA to program Nvidia GPUs. Topics include • The GPU as part of the PC architecture • GPU architecture • GPU programming model • Memory management • Thread model • Parallel programming patterns, including histogram, stencil, reduction, scan • Example algorithms, including matrix computation, sorting, graph search
Learning outcomes and qualification goals	Expertise: know basic concepts of GPUs and GPU programming, both from a hardware and from a software perspective
	Methodological competence: learn how to implement efficient parallel algorithms for GPUs
	Personal competence: learn to organize yourself when studying by yourself or in groups
Media	Video lectures, literature
Literature	• Jason Sanders, Edward Kandrot: “CUDA by Example: An Introduction to General-Purpose GPU Programming”, Addison-Wesley Professional, 2010 • Jaegeun Han, Bharatkumar Sharma: “Learn CUDA Programming: A beginner's guide to GPU programming

	and parallel computing with CUDA 10.x and C/C++", Packt Publishing, 2019 • David A. Patterson, John L. Hennessy: "Computer Organization and Design (ARM Edition): The Hardware/Software Interface", Morgan Kaufmann, 2016 • David B. Kirk, Wen-mei W. Hwu: "Programming Massively Parallel Processors: A Hands-On Approach", 3rd ed., Morgan Kaufmann, 2016
Methods	Lectures and exercises in self-study, Q&A sessions
Form of assessment	Oral exam
Admission requirements for assessment	-
Duration of assessment	30 minutes
Language	English
Offering	irregular
Lecturer	Prof. Dr. Guido Moerkotte, Daniel Flachs, Magnus Müller
Person in charge	Prof. Dr. Guido Moerkotte
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, M.Sc. Wirtschaftsmathematik
Semester	1st / 2nd / 3rd 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 C++
Aim of module	• Diffusion Filters, TV minimization • Image Segmentation • Combinatorial optimization • Spectral Clustering • Optical Flow • Video and Motion Segmentation • 3D Geometry (Camera Calibration, Stereo Reconstruction) • Structure from Motion • Deep Learning for Computer Vision
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 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 (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 or oral examination (TBA)
Admission requirements for assessment	-
Duration of assessment	90 minutes (Written examination) or 15 minutes (Oral examination)
Language	English
Offering	Spring semester
Lecturer	Juniorprofessor Dr.-Ing. Margret Keuper
Person in charge	Juniorprofessor Dr.-Ing. Margret Keuper
Duration of module	1 Semester
Further modules	Image Processing
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
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 C++
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 • Image Sequences and Motion (Optical Flow) • 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 (Online available: http://cmuems.com/excap/readings/forsyth-ponce-computer-vision-a-modern-approach.pdf)
Methods	Lecture, weekly exercise, book studies, implementation of algorithms, visualization of results
Form of assessment	Written or oral examination (TBA)
Admission requirements for assessment	-
Duration of assessment	90 minutes (Written examination) or 15 minutes (Oral examination)
Language	English
Offering	Fall Semester
Lecturer	Juniorprofessor Dr.-Ing. Margret Keuper
Person in charge	Juniorprofessor Dr.-Ing. Margret Keuper
Duration of module	1 Semester
Further modules	Computer Vision
Range of application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

CS 651	**Kryptographie II**
Form der Veranstaltung	Inverted classroom
Typ der Veranstaltung	Specialization course
Modulniveau	Master
ECTS	6
Arbeitsaufwand	Präsenzstudium: 56 h pro Semester (4 SWS)
	Eigenstudium: 112 h pro Semester • davon Vor- und Nachbereitung der Veranstaltung und freies Selbststudium: 84 h pro Semester • davon Vorbereitung für die Prüfung, z. B. Prüfungs-/Seminarabschlussarbeits- und Präsentationsvorbereitung: 28 h pro Semester
Vorausgesetzte Kenntnisse	Es gibt keine formalen Voraussetzungen, aber folgende inhaltliche Vorkenntnisse werden empfohlen: Grundkenntnisse in der Kryptographie, wie sie bspw. in der Vorlesung “Kryptographie I” erworben werden können. CS 550 Algorithmik
Lehrinhalte	In der Vorlesung erfolgt eine kurze Zusammenstellung der wichtigsten kryptographischen Grundalgorithmen und der für die Vorlesung relevanten mathematischen, algorithmischen und informations- und komplexitätstheoretischen Grundlagen. Diese werden einerseits vertieft und andererseits erweitert. Behandelte Themen sind beispielsweise • moderne Techniken der Kryptanalyse und daraus ableitbare Designkriterien für kryptographische Verfahren • kryptographische Protokolle • Sicherheitsbeweise
Lern- und Kompetenzziele	Fachkompetenz: Die Studierenden können Mithilfe aktueller Techniken und Theorien der modernen Kryptographie die Sicherheit von kryptographischen Verfahren einschätzen bzw. Sicherheitsaussagen entsprechend zu beurteilen. Weiterhin sind sie in der Lage, Sicherheitsziele zu erkennen

	und entsprechende Techniken einzusetzen, die in Kryptographie I nicht behandelt werden konnten. (MK2)
	Methodenkompetenz: Den Studierenden sind in der Lage, geeignete Methoden zu Sicherheitsanalyse von kryptographischen Verfahren auszuwählen und einzusetzen. Dazu gehören bspw. die Wahl der passenden Sicherheitsmodelle, das Beweisen der Sicherheit aufgrund klar präzisierter Annahmen und die Analyse gegebener Verfahren. Insbesondere besitzen die Studierenden die Fähigkeit, die Sicherheitsargumente für existierende Verfahren zu verstehen und einzuschätzen und auf neue zu übertragen. Weiterhin können sie Techniken und Protokolle einsetzen, um Sicherheitsziele zu erreichen, die mit den in Kryptographie I besprochenen Verfahren noch nicht möglich waren. (MK1)
	Personale Kompetenz: Das analytische, konzentrierte und präzise Denken der Studierenden wird geschult. Durch die eigenständige Behandlung von Anwendungen, z.B. im Rahmen der Übungsaufgaben, wird ihr Abstraktionsvermögen weiterentwickelt und der Transfer des erlernten Stoffes auf verwandte Fragestellungen gefördert. (MF1, MK03)
Medienformen	Anschrieb (Tafel, elektronisch), Folien, Handouts
Begleitende Literatur	• Jonathan Katz, Yehuda Lindell: Introduction to Modern Cryptography: Principles and Protocols, Chapman and Hall/CRC, 2007.
Lehr- und Lernmethoden	Nacharbeit der Vorlesung und Studium der relevanten Literatur im Selbststudium, gemeinsames Durcharbeiten konkreter Beispiele während der Vorlesung, Lösen von Übungsaufgaben im Selbststudium und in der Übung in Kooperation mit den Kommilitonen
Art der Prüfungsleistung	Schriftliche oder mündliche Prüfung
Prüfungsdauer	90 Minuten (schriftliche Prüfung) 30 Minuten (mündliche Prüfung)

Sprache	Deutsch, auf Wunsch englisch
Angebotsturnus	HWS
Lehrende/r	Prof. Dr. Frederik Armknecht, Prof. Dr. Matthias Krause
Modulverantwortliche	Prof. Dr. Frederik Armknecht, Prof. Dr. Matthias Krause
Dauer des Moduls	1 Semester
Weiterführende Module	-
Verwendbarkeit	M.Sc. Wirtschaftsinformatik, M.Sc. Wirtschaftsmathematik, Lehramt Informatik
Einordnung in Fachsemester	1. /2. /3. Semester

CS 652	**Data Security**
Form of module	Lecture with exercises
Type of module	Specialization course
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 cloud computing or possibly unconsciously as in the case of the Internet of Things. The aim of the module is to raise awareness by showing various security threats, e.g., traces left in the Internet, but also possible countermeasures, e.g., anonymization of data or the use of dedicated encryption schemes.
Learning outcomes and qualification goals	Expertise: Students will acquire the knowledge to identify security threats and to select and use appropriate countermeasures. (MK2)
	Methodological competence: Successful participants will be able to understand state-of-the-art methods of IT security and cryptography, as well as being able to select, apply and evaluate the most appropriate techniques for a variety of different security-sensitive scenarios. In particular they are able to realize possible risks in new scenarios and to transfer given solutions to these.
	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.
Media	Annotated lecture slides, exercise sheets
Literature	Will be announced in the lecture

Methods	Reworking the lecture and studying the relevant literature in self-study, working together on concrete examples during the lecture, 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	Spring semester
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
Semester	1st/2nd/3rd semester

CS 654	**Internet of Things Security**
Form of module	Lecture and accompanying practical sessions
Type of module	Specialization course
Level	Master
ECTS	6
Workload	4 SWS
	Self-study: 112 h per semester 56 h: pre and post lecture studying and revision • 28 h: practical task completion 28 h: examination preparation
Prerequisites	Programming skills in C or C++
Aim of module	The course provides an introduction to the security of Internet of Things (IoT). It will cover the following topics: • Relevant attacks in the modern Industrial and Consumer IoT environments • Programming of IoT devices • Cryptography suitable for devices with constrained resources • Implementation techniques targeting different goals • IoT standards and protocols
Learning outcomes and qualification goals	Expertise: Students will acquire the knowledge about the most relevant security threats in IoT environments, as well as suitable security solutions
	Methodological competence: analysing and understanding of security weaknesses, implementation of protection mechanisms
	Personal competence: the student has the capability to program IoT devices targeting different optimization goals. The student understands the main attacks on IoT devices together with countermeasures.
Media	Lecture and tutorial slides, exercise sheets
Literature	-
Methods	The course consists of lectures and exercises. At the exercise sessions the students will learn how to implement cryptographic

	algorithms on Arduino Uno devices which will be distributed to each participant. Each student will also receive an individual practical task that needs to be accomplished until the end of the term and the report has to be submitted.
Form of assessment	Practical tasks + oral examination
Admission requirements for assessment	Successful completion of the practical task
Duration of assessment	20 minutes
Language	English
Offering	Fall Semester
Lecturer	Dr. Matthias Hamann, Dr. Vasily Mikhalev, Christian Müller
Person in charge	Dr. Vasily Mikhalev
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

ii. IE-Courses

IE 630	Query Optimization
Form of module	Lecture
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 2h per week
	Self-study: 4h per week
Prerequisites	DBSI, Algorithms & Datastructures, C++
Aim of module	The lecture introduces basic concepts needed to implement a plan generator.
Learning outcomes and qualification goals	Expertise: know basic plan generation concepts
	Methodological competence: learn how to program plan generators efficiently
	Personal competence: learn how to listen carefully
Media	Beamer & blackboard
Literature	tba
Methods	The course will introduce concepts which the student can then implement.
Form of assessment	Oral exam
Admission requirements for assessment	-
Duration of assessment	30 minutes
Language	English
Offering	Spring semester
Lecturer	Guido Moerkotte
Person in charge	Guido Moerkotte
Duration of module	1 semester

Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, MMDS
Semester	1st / 2nd / 3rd semester

IE 650	Semantic Web Technologies
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 programming skills
Aim of module	• Vision and Principles of the Semantic Web • Representation Languages (XML, RDF, RDF Schema, OWL) • Knowledge Modeling: Ontologies and Linked Data • Logical Reasoning in RDF and OWL • Commercial and Open Source Tools and Systems
Learning outcomes and qualification goals	Expertise: The participants of this course learn about principles and applications of Semantic Web standards. 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 semantic 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 Semantic Web applications. 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 semantic web 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 excercise sheets will be available online
Literature	• Pascal Hitzler, Markus Krötzsch and Sebastian Rudolph, Foundations of Semantic Web Technologies, Chapman & Hall/CRC, 2009 • Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph and York Sure, Semantic Web – Grundlagen, Springer, 2008 • Allemang and Hendler (2008): Semantic Web for the Working Ontologist. Verlag Morgan Kaufmann. • Antoniou and van Harmelen (2004): A Semantic Web Primer. MIT Press. • Heath and Bizer (2011): Linked Data: Evolving the Web into a Global Data Space. Free online version available.
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 excercises, 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	Prof. Dr. Heiko Paulheim
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 Informatik
Semester	1st/2nd/3rd semester

IE 661	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.
Aim of module	In the digital age, techniques to automatically process textual content have become ubiquitous. Given the breakneck speed at which people produce and consume textual content online – e.g., on micro-blogging and other collaborative Web platforms like wikis, forums, etc. – there is an ever-increasing need for systems that automatically understand human language, answer natural language questions, translate text, and so on. This class will provide a complete introduction to state-of-the-art principles and methods of Natural Language Processing (NLP). The main focus will be on statistical techniques, and their application to a wide variety of problems. This is because statistics and NLP are nowadays highly intertwined, since many NLP problems can be formulated as problems of statistical inference, and statistical methods, in turn, represent de-facto the standard way to solve many, if not the majority, of NLP problems.
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge of state-of-the-art principles and methods of Natural Language Processing, with a specific focus on the application of 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, as well as being able to select, apply and evaluate the most appropriate techniques for a variety of different practical and application-oriented scenarios. (MF3)
	Personal competence: • presentation skills • team work skills

	(MKO1, MKO3)
Media	Lecture and tutorial slides, exercise sheets
Literature	• Chris Manning and Hinrich Schütze, Foundations of Statistical Natural Language Processing, MIT Press 1999; • Dan Jurafsky and James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, Prentice Hall 2009 (2nd edition).
Methods	Lectures, tutorials
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, MSc. Mannheim Master in Data Science, Lehramt Informatik, M. Sc. Medien- und Kommunikationswissenschaft, PhD Volkswirtschaftslehre
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 (if practically not all) of Web applications. In this course, we will explore a variety of basic and advanced 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, MF1)
	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.
	Personal competence: -
Media	Lecture slides, exercise sheets
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	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	Spring semester
Lecturer	Dr. Goran Glavas
Person in charge	Dr. Goran Glavas
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, MSc. Mannheim Master in Data Science, 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. 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 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, Lehramt Informatik
Semester	1st/2nd/3rd semester

IE 671	**Web Mining**
Form of module	Lecture
Type of module	Specialization course
Level	Master
ECTS	3
Workload	Hours per semester: 28 h (2 SWS)
	Self-study: 56 h per semester • 31 h: pre and post lecture studying and revision • 25 h: examination and presentation preparation
Prerequisites	IE 500 Data Mining I (recommended). Fundamental notions of linear algebra and probability theory.
Aim of module	Structured and unstructured data available on the Web provide us with a goldmine of information that has the potential to enable cutting-edge intelligent applications. This class covers a variety of topics focused on mining techniques for Web data, including extracting knowledge from Web content (Web Content Mining), the link structure of the Web (Web Structure Mining), as well as mining usage data gathered by Web applications (Web Usage Mining). 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. 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, Lehramt Informatik
Semester	1st/2nd/3rd semester

IE 672	Data Mining II
Form of module	Lecture with exercises and project
Type of module	Specialization course
Level	Master
ECTS	6
Workload	Hours per semester: 56 h (4 SWS)
	Self-study: 112 h per semester • 56 h: pre and post lecture studying and revision • 56 h: examination and presentation preparation
Prerequisites	Knowledge in Data Mining, programming skills in Java
Aim of module	Data mining deals with the discovery of patterns in data, and with making predictions for the future, based on observations of the past. This course covers advanced issues in data mining which need to be addressed when applying data mining methods in real world projects, including: • Data Preprocessing • Dimensionality Reduction • Anomaly Detection • Time Series Analysis • Parameter Tuning • Ensemble Learning
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge of advanced techniques and applications of data mining. (MK2, MF1,MF3)
	Methodological competence: • Successful participants will be able to address advanced issues in data mining projects, conduct complex projects and develop applications in the data mining field. • project organization skills (MK2, MF3, MF4, MF5, MKO1, MKO3)
	Personal competence: • presentation skills • team work skills (MKO2, MF2)
Media	slide set, exercise sheets, data sets for the exercises

Literature	• Pang-Ning Tan, Michael Steinbach, Vipin Kumar: Introduction to Data Mining, Pearson. • Ian H. Witten, Eibe Frank, Mark A. Hall: Data Mining: Practical Machine Learning Tools and Techniques, 3rd Edition, Morgan Kaufmann. • Jiawei Han and Micheline Kamber: Data Mining – Concepts and Techniques • Albert Bifet: Adaptive Stream Mining • Joao Gama: Knowledge Discovery from Data Streams
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. In the team projects, which take place in the last third of the term, the students work on an advanced data mining task, which is provided by the annual Data Mining Cup and/or the course organizers.
Form of assessment	Written examination
Admission requirements for assessment	Project report and oral presentation
Duration of assessment	60 minutes
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Heiko Paulheim
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 Informatik
Semester	1st/2nd/3rd semester

IE 674	**Hot Topics in Machine Learning**
Form of module	Lecture with exercises
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester: 56h (4 SWS)
	Self-study per semester: 98 h • 70 h: pre- and post-lecture studying and revision • 28 h: exam preparation
Prerequisites	IE 675 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. This course builds upon IE 675 Machine Learning and introduces advanced algorithms, concepts, and theoretical principles. The course also focuses on selected „hot topics" and their applications. Tentative topics include: • Deep learning (models, applications, training methods, libraries) • Probababilistic models • Matrix and tensor decompositions • Graph analysis • AutoML • Active learning
Learning outcomes and qualification goals	Expertise: Deep understanding of advanced algorithms and concepts of machine learning (MK1, MF1)
	Methodological competence: • Being able to apply advanced machine learning techniques and systems for a given problem • Being able to model and implement advanced 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. *Machine Learning: A Probabilistic Perspective*, The MIT Press, 2012 • D. Koller, N. Friedman. *Probabilistic graphical models*. The MIT Press, 2009 • 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	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 675	**Machine Learning**
Form of module	Lecture with exercises
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester: 56h (4 SWS)
	Self-study per semester: 98 h • 70 h: pre- and post-lecture studying and revision • 28 h: exam preparation
Prerequisites	IE 500 Data Mining I (recommended), knowledge of probability and statistics
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. • Basics of machine learning and probability theory • Inference and prediction • Selected classification and regression models • Latent linear models • Mixture models and EM • Kernel methods
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. *Machine Learning: A Probabilistic Perspective*, The MIT Press, 2012 • D. Koller, N. Friedman. *Probabilistic graphical models*. The MIT Press, 2009 • 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	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
Semester	1st/2nd/3rd semester

IE 676	Network Analysis
Form of module	Lectures and Accompanying tutorials
Type of module	Elective
Level	Master
ECTS	*6*
Workload	*Hours per semester present: 28h + 46 h (2 + 2 SWS)*
	Self-study: 112 h per semester
Prerequisites	Recommended Knowledge: • Basic Linear Algebra • Basic Computer Programming • Basic Probabilities
Aim of module	Participants will learn about the structure, formation and processes that take place over networks such as social networks, the Web, financial networks, etc. They will learn basic concepts, measures and algorithms for analyzing such structures with a particular focus on the interpretation of the results and their implication in real-life situations.
Learning outcomes and qualification goals	Expertise: Students will acquire knowledge in a broad range of methods for analyzing networked data and their results' interpretation.
	Methodological competence: Successful participants will be able to: • Recognize the existence of networked structure in data; • Select and apply appropriate techniques to explore a networked structure and to analyze network effects like: identify key players, find communities, analyze processes such as diffusion of information, network formation and growth, epidemics, etc. • Interpret the results both theoretically and practically on real-life networks. (MK2, MF3, MF4, MKO1)
	Personal competence: -
Media	Lecture Slides, Exercise Sheets, Blackboard, Books, Software Tools
Literature	• Networks – An Introduction: M. E. J Newman, Oxford University Press, 2010

	• Networks, crowds and markets. Reasoning about a Highly Connected World – David Easley & Jon Kleinberg, Cambridge University Press 2010 • Social and Economic Networks: M.O. Jackson, Princeton University Press 2008
Methods	Lectures, exercises (pen on paper and programming), independent study
Form of assessment	Written examination
Admission requirements for assessment	Successful completion of the programming exercises;
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, Mannheim Master in Data Science
Semester	2.-4.

IE 691	Information Retrieval Project
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 • 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-worls 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	• Software, code and documentation (60%) • Written project report (30%) • Oral project presentation (10%)
Admission requirements for assessment	-
Duration of assessment	-
Language	English
Offering	Spring semester
Lecturer	Prof. Dr. Goran Glavaš
Person in charge	Prof. Dr. Goran Glavaš
Duration of module	1 semester
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik, Mannheim Master in Data Science, Lehramt Informatik
Semester	1st/2nd/3rd semester

IE 683	**Web Data Integration Project**
Form of module	Project
Type of module	Specialization course
Level	Master
ECTS	3
Workloadk	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
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 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%), oral project presentation (30%)
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 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%), oral project presentation (30%)
Admission requirements for assessment	-
Duration of assessment	-
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, Mannheim Master in Data Science Lehramt Informatik
Semester	1. /2. /3. Semester

IE 689	Relational Learning
Form of module	Lectures and accompanying tutorials
Type of module	Elective
Level	Master
ECTS	6
Workload	Hours per semester present: 28 h (2 SWS)
	Self-study: 112 h per semester
Prerequisites	Recommended Knowledge: • Data Mining • First-Order Logic • Problem Solving as Search
Aim of module	Participants will be introduced to a specific form of Machine Learning that aims at learning relational rules from relational data. They should understand the strengths and limitations of this type of machine learning methods in comparison to propositional learning approaches and methods using embeddings. As an important part of the course students will gather practical experiences using some of the methods on example data.
Learning outcomes and qualification goals	Expertise: Students will acquire basic knowledge of the techniques, opportunities and applications of logical learning methods. (MK1, MK2)
	Methodological competence: Successful participants will be able to identify opportunities for relational learning methods, select and apply appropriate techniques, and interpret the results. (MK2, MF3, MF4, MKO1)
	Personal competence: -
Media	Slides, Book, Software Tools
Literature	• De Raedt. Logical and Relational Learning. Springer 2010. Chapters 1 – 6. • Galarraga et al. AMIE: association rule mining under incomplete evidence in ontological knowledge bases. WWW 2013. • Meilicke et al. Anytime bottom-up rule learning for knowledge graph completion. IJCAI 2019.

Methods	Lectures, excercises, homework, independent study
Form of assessment	Written examination
Admission requirements for assessment	Successful participation in the exercises
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, Mannheim Master in Data Science
Semester	2./3./4. semester

iv. International Course

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

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 • 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 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. 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
Media	Depends on project
Literature	Depends on topic
Methods	Team-discussions, Presentations, Teamwork, Individual preparation of empirical contributions; self-study
Form of assessment	Final report and presentation
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	30 minutes (presentation)
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	A professor 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	Seminar
Type of module	Key Qualification
Level	Master
ECTS	2
Workload	Block seminar (3 days)
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	Seminar
Form of assessment	Written examination

Admission requirements for assessment	-
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	3 days
Further modules	-
Range of application	M.Sc. Wirtschaftsinformatik
Semester	1st/2nd/3rd semester

iii. Seminars

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 beamerLatex.
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 groups of peers.

Form of assessment	Presentation, Paper, Participation
Admission requirements for assessment	Timely hand-in of seminar papers and presentation materials
Duration of assessment	60 min presentation and 15 min discussion
Language	English
Offering	Spring semester
Lecturer	Matthias Krause, Alexander Moch, Matthias Hamann
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.
	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	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	30% Presentation (takes place after one month) 70% Seminar Report (has to be submitted after three month)
Admission requirements for assessment	-
Duration of Assessment	N/A

Language	English
Offering	Various seminar topics every semester, see announcements on the Internet.
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 705	Datenbankseminar
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	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	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	Grading of the seminar paper, the oral presentation and the participation in the group discussions (Notification will be given at the start of the lecture period for this module)
Admission requirements for assessment	-
Duration of Assessment	N/A

Language	German/English
Offering	HWS/FSS
Lecturers	Prof. Dr. Guido Moerkotte
Person in charge	Prof. Dr. Guido Moerkotte
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	Seminar Data and Web 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	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 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	Individual grading of the seminar paper, the oral presentations, the peer reviews (if applicable), the created source code (if applicable), the active participation in the seminar, and the timeliness of hand-ins. (Notification will be given at the start of the lecture period for this module)
Admission requirements for assessment	-

Duration of Assessment	N/A
Language	English
Offering	Every semester
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 degree, the fundamentals
Aim of module	Students 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. 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 find the relevant literature for his/her topic, 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 find relevant literature for a research topic, write a well-structured, concise paper about it and give a presentation.
Media	Scientific papers and books, final 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. Active discussions in a group of peers.
Form of Assessment	Quality of the seminar paper and the oral presentation. (Notification will be given at the start of the lecture period for this module)
Language	English
Offering	Specific seminar topics are suggested every semester, see announcements on the group website.
Lecturer	Member of the software engineering group

Duration	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	IE 661 “Text Analytics” or IE 663 “Web Search and Information Retrieval”. 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. 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.
	Methodological competence: Students will develop methods and skills to find relevant literature for his/her topic, to write a well-structured survey/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.
	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. He/she is 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	Seminar report (70%), oral presentation (30%)
Admission requirements for assessment	-
Duration of Assessment	N/A
Language	English or German

Offering	Various seminar topics every semester, see announcements on the Internet / Website
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.
	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.
	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.
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	Grading of the seminar paper, Peer Review, Presentation
Admission requirements for assessment	-
Duration of Assessment	N/A

Language	English or German
Offering	Spring 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	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, Lehramt für Gymnasien
Semester	3rd semester

CS 715	Large-Scale Data Integration Seminar
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 Information Extraction, Schema Matching, Identity Resolution, Data Fusion, Data Mining, Web 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.
	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.
	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.
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	Grading of the seminar paper
Admission requirements for assessment	-

Duration of Assessment	N/A
Language	English
Offering	Spring Semester
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, 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 degree, the fundamentals
Aim of module	The student prepares a scientific report and 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). Research report and presentation 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 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. 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 a presentation. He/she 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 seminar paper, the oral presentation, and the participation in the group discussions and review phases.
Admission requirements for assessment	Timely hand-in of seminar paper, presentation, peer-reviews
Duration of Assessment	N/A
Language	English

Offering	Fall semester
Lecturers	N.N.
Person in charge	N.N.
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 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 pla- giarism. 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	Scientific papers and books
Literature	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	30% Presentation (takes place after one month) 70% Seminar Report (has to be submitted after three months)

Admission requirements for assessment	
Duration of assessment	N/A
Language	English
Offering	HWS
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.
	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.
	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.
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	Grading of the seminar paper, Peer Review, Presentation

Admission requirements for assessment	
Duration of Assessment	N/A
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 719	Seminar on Process Analysis
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	150 h per semester
Prerequisites	Any course about process modeling, analysis, or mining
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 scientific report and presentation about the results. Topics of interest relate to research areas such as process analysis, process mining, stream processing, and robotic process automation. The paper and the presentation are prepared under the guidance of a professor and/or a research staff member. Specific topics shall be suggested by the lecturers, though students are free to make proposals as well.
Learning Outcomes and Qualification Goals	Expertise: Students will acquire a deep understanding of the research topic. They are expected to describe and summarize the topic 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 prepare methodologically sound scientific experiments (if applicable), to write a well-structured scientific paper, and to present their results. Students will also be 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. They will be well prepared to write and present a Master's Thesis.
Media	Scientific papers and books; presentation with PowerPoint or LaTeX

Literature	Depends on the selected topic of the seminar
Teaching and Learning Methods	Conduct scientific work independently under the guidance of a professor or research staff member
Form of assessment	Seminar report (70%), oral presentation (30%)
Admission requirements for assessment	-
Duration of assessment	N/A
Language	English
Offering	Fall semester
Lecturers	Prof. Dr. Han van der Aa and research staff members
Person in charge	Prof. Dr. Han van der Aa
Duration of module	1 semester
Further modules	-
Range of Application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	3rd semester

IE 704	Seminar AI Systems Engineering
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	None
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 supervisors. The paper and the presentation are prepared under the guidance of a research staff member. Active participation in the seminar discussions is expected.
Learning Outcomes and Qualification Goals	<u>Expertise:</u> The student gains a deep understanding of the research topic. 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.
	<u>Methodological competence:</u> 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.
	<u>Personal qualification:</u> The student has learned how to write a well-structured, concise paper and give a presentation. This is part of the preparation to write and present a Master's Thesis.
Media	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	25% Reviews and Discussion 25% Presentation 25% Seminar paper submitted for review 25% "Camera-ready" seminar paper
Admission requirements for assessment	-
Duration of Assessment	N/A
Language	English

Offering	Various seminar topics every semester, see announcements on the chair website.
Lecturers	Dr. Christian Bartelt
Person in charge	Dr. Christian Bartelt
Duration of module	1 Semester
Further modules	-
Range of Application	M.Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science
Semester	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 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. He/she is able to conduct basic scientific research. He/she reflects on the topic and judges the contribution of the research papers.
	Methodological competence: The student is able to find the relevant literature for his/her topic, 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 find relevant literature for a research topic, write a well-structured, concise paper about it and give a presentation. He/she is 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	Grading of the seminar paper, the oral presentation and the participation in the group discussions (Notification will be given at the start of the lecture period for this module)

Admission requirements for assessment	-
Duration of Assessment	N/A
Language	English
Offering	Various seminar topics every semester, see announcements on the chair website.
Lecturers	Prof. Dr. Armin Heinzl and research assistants
Person in charge	Dr. Kai Spohrer
Duration of module	1 Semester
Further modules	-
Range of Application	Mannheim Master in Management, M.Sc. Business Informatics
Semester	3. Semester

IS 722	**Seminar Trends in Distributed Systems**
For a detailed description please use the module catalog of the „Mannheim Master in Management”: https://www.bwl.uni-mannheim.de/studium/master-studiengaenge/mannheim-master-in-management/	

IS 742	**Seminar Trends in Enterprise Systems**
For a detailed description please use the module catalog of the „Mannheim Master in Management”: https://www.bwl.uni-mannheim.de/studium/master-studiengaenge/mannheim-master-in-management/	

IS 751	**E-Government Adoption and Societal Change**
For a detailed description please use the module catalog of the „Mannheim Master in Management”: https://www.bwl.uni-mannheim.de/studium/master-studiengaenge/mannheim-master-in-management/	

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
Admission requirements for assessment	-
Duration of Assessment	-
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