Master of Science (M.Sc.)

„Business Informatics“

University of Mannheim

– Module catalog –

for students starting in spring 2018 or later

Appendix

Academic Year

HWS 2022/ FSS 2023

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

B. Fundamentals

i. Fundamentals Computer Science

Module no.	Name of Module	Offered	Language	ECTS	Page
CS 404	Kryptographie I/ Cryptographie I	FSS	E	6	3
CS 408	Selected Topics in IT-Security	FSS	E	6	6

C. Specialization Courses

i. CS-Courses

Module no.	Name of Module	Offered	Language	ECTS	Page
CS 667	Computer Vision	HWS	E	6	7
CS 664	Blockchain Security	HWS	E	6	9
CS 644	Computer Graphics	FSS	E	6	10

ii. IE-Courses

Module no.	Name of Module	Offered	Language	ECTS	Page
IE 695	Reinforcement Learning**	FSS	E	6	12

Other Specialization Courses

MAB 519	Reinforcement Learning**	Spring	E	9	M.Sc. Wima und M.Sc. Mathematik*

*For a detailed description, please see the module catalog of the respective following degree programs:
M.Sc. Wima and M.Sc. Mathematik: https://www.wim.uni-mannheim.de/studium/studienorganisation/m-sc-wirtschaftsmathematik/#c109976

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

D. Projects and Seminars

iii. Seminar

Module no.	Name of Module	Offered	Language	ECTS	Page
CS 722	Seminar Ethical Aspects of AI	FSS	E	4	10

B. Fundamentals

i. Fundamentals Computer Science

CS 404	**Kryptographie I** ***Cryptographie I***
Form der Veranstaltung	Vorlesung mit begleitender Übung
Typ der Veranstaltung	Vertiefung Informatik
Modulniveau	Bachelor
ECTS	6
Arbeitsaufwand	Präsenzstudium: 56 h pro Semester (4 SWS)

	Eigenstudium: ca. 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: Praktische Informatik I und II, Lineare Algebra, Algorithmen und Datenstrukturen, Analysis, Einführung in die Statistik
Lehrinhalte	In der Vorlesung erfolgt eine Einführung in die moderne Kryptographie, d.h. in die Theorie und der Praxis der Absicherung von digitalen Daten. Neben der Bereitstellung der für das Verständnis des Stoffs nötigen mathematischen, algorithmischen und informationstheoretischen Grundlagen werden vor allem die grundlegenden Konzepte und mehrere in der Praxis eingesetzte Verfahren vorgestellt. Behandelt Themen sind beispielsweise: • Grundbegriffe der Kryptographie • Blockchiffren, z.B. Data Encryption Standard (DES) und Advanced Encryption Standard (AES), und Stromchiffren • Verfahren zum sicheren Schlüsselaustausch, bspw. das Diffie-Hellman Protokoll • Public-Key Verschlüsselungsverfahren, bspw. RSA • Hashfunktionen • Message Authentication Codes
Lern- und Kompetenzziele	Fachkompetenz: Nach Abschluss des Moduls sind die Studierenden befähigt, die größten Risiken im elektronischen Datenverkehr, wie sie bspw. beim Online-Banking oder Einkauf über Online-Händler wie Amazon auftreten können, zu erkennen und zu vermeiden. (BK1, BK2, BK7)
	Methodenkompetenz: Die Studierenden können in konkreten Anwendungsfällen notwendige Sicherheitsziele erkennen und passende Methoden auswählen und einsetzen. Beispiele sind Verfahren zur Geheimhaltung von Daten (Verschlüsselungen), den Aufbau einer vertrauenswürdigen

	Verbindung (Schlüsselaustausch) und der sicheren Authentifikation (Zertifikate und digitale Signaturen). (BK5, BF4, BF5)
	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. (BKO2)
Medienformen	Anschrieb (Tafel, elektronisch), Folien, Handouts
Begleitende Literatur	• Christof Paar, Bart Preneel, Jan Pelzl: Understanding Cryptography: A Textbook for Students and Practitioners, Springer, 2009. • Douglas R. Stinson: Cryptography - Theory and Practice, Taylor & Francis, 2005. • Alan G. Konheim: Cryptography: A Primer, John Wiley & Sons, 1981.
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 Prüfung
Prüfungsvorleistungen	-
Prüfungsdauer	90 Minuten
Sprache	Englisch
Angebotsturnus	Frühjahrssemester
Lehrende/r	Prof. Dr. Frederik Armknecht, Prof. Dr. Matthias Krause
Modulverantwortlicher	Prof. Dr. Frederik Armknecht, Prof. Dr. Matthias Krause
Dauer des Moduls	1 Semester
Weiterführende Module	-

Verwendbarkeit	B.Sc. Wirtschaftsinformatik, B.Sc. Wirtschaftsmathematik, M.Sc. Wirtschaftspädagogik, Lehramt Informatik, Beifach Angewandte Informatik. M.Sc. Wirtschaftsinformatik
Einordnung in Fachsemester	5./6. Fachsemester

CS 408	**Selected Topics in IT-Security**
Form of module	Inverted classroom with exercises
Type of module	Vertiefung Informatik
Level	Bachelor
ECTS	6
Workload	Hours per semester present: 56h (4 SWS) Self-study: 112h
Prerequisites	No formal prerequisites. However, knowledge with respect to the content of the following lectures are suggested: • Praktische Informatik I and II, programming
Aim of module	This course aims to increase the security awareness of students and offers them a basic understanding with respect to a variety of relevant IT-security topics. Possible topics are: • Security Goals • Crash course in Cryptography • Access Control • Authentication • Social Engineering • E-Mail Security • System Vulnerabilities • Malware • Hardware Security • Network Security • Web Security • Trust Risk Assessment
Learning outcomes and qualification goals	Expertise: Students will acquire the knowledge to identify security threats and to select and use appropriate countermeasures. (MK2)
Lern- und Kompetenzziele	Methodological competence: Successful participants will be able to understand, to select, apply and evaluate the most appropriate techniques for a variety of different privacy-sensitive scenarios. In particular they are able to realize possible risks in new scenarios and to transfer given solutions to these.

	(MK1)
Medienformen	Personal competence: The analytic, concentrated, and precise thinking of the students is trained. By the independent treatment of applications, e.g. in the course of the exercises, their abstraction capacity is further developed and the transfer of the learned material to related questions is trained. (MF1, MK03)
Media	Video recordings, annotated lecture slides
Literature	none
Methods	Reworking the lecture and studying the relevant literature in self-study. During the lecture: discussing questions and ideas and working together on concrete examples. Solving exercises in self-study and in practice in cooperation with fellow students.
Form of assessment	Written exam
Admission requirements for assessment	none
Duration of assessment	90 minutes
Language	English
Offering	FSS
Lecturer	Prof. Dr. Frederik Armknecht
Person in charge	Prof. Dr. Frederik Armknecht
Duration of module	1 Semester
Further modules	-
Range of application	B.Sc. Wirtschaftsinformatik, B.Sc. Medien- und Kommunikationswissenschaft, M.Sc. Wirtschaftspädagogik, Lehramt Informatik, Beifach Angewandte Informatik, M.Sc. Wirtschaftsinformatik

C. Specialization Courses

i. CS-Courses

CS 667	**Computer Vision**
Form of module	Lecture with Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4SWS)
Prerequisites	Basis skills in linear algebra, basis knowledge in python, machine learning; No completed exam in Higher Level Computer Vision (CS 646)
Aim of module	- CNNs, generative models and RNNs for computer vision - Detection, segmentation etc. - Self-supervised learning - Recent trends, e.g. transformers
Learning outcomes and qualification goals	Expertise: The students have a detailed understanding of modern computer vision techniques based on machine learning. They can understand and evaluate given computer vision algorithms.
	Methodological competence: Students understand the technical basis of computer vision algorithms; they can explain the discussed methods and implement them.

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

CS 664	**Blockchain Security**
Form of module	Inverted classroom with exercises
Type of module	Specialization course
ECTS	6
Workload	Hours per semester present: 56h (4 SWS), Self-study: 112h
Prerequisites	There are no formal prerequisites but knowledge in cryptography and/or IT-security is recommended, e.g., by attending the lectures “Kryptographie I” or “Selected Topics in IT-Security”
Aim of module	Blockchains promise secure and reliable data storage and consensus in a trustless environment. In the light of their growing popularity, Blockchain security becomes increasingly important. The course will equip students with a solid understanding of blockchains, their design principles, underlying technologies and cryptographic primitives. Bitcoin, Monero and Ethereum will be discussed in greater detail and a substantial part of the course will be devoted to security issues and possible attacks.
Learning outcomes and qualification goals	Expertise: Students will acquire profound knowledge of Blockchain technology as well as the skills to critically examine the security of Blockchain-based systems. Methodological competence: Successful participants will be able to understand and evaluate the different ways in which different Blockchain systems try to achieve security. They will also be able to identify where, why and how these security measures are broken for both, current and new systems. Personal competence: The analytic, concentrated, and precise thinking of the students is trained. As multiple different but related Blockchains are discussed, their abstraction capacity is further developed and the transfer of the learned concepts to related questions is trained.
Media	Video recordings, annotated lecture slides
Literature	Will be announced in the lecture
Methods	Reworking the lecture and studying the relevant literature in self-study. During the lecture: discussing questions and ideas and working together on concrete examples. Solving exercises in self-study and in practice in cooperation with fellow students.
Form of assessment	Written exam
Admission requirements for assessment	-
Duration of assessment	90 Minutes
Language	English
Offering	HWS
Lecturer	Prof. Dr. Frederik Armknecht
Person in charge	Prof. Dr. Frederik Armknecht
Duration of Module	1 Semester
Further Modules	-
Range of application	M.Sc. Mannheim Master in Data Science,

	M.Sc. Wirtschaftsinformatik Lehramt Informatik M.Sc. Mathematik M.Sc. Wirtschaftsmathematik
Semester	1st/2nd/3rd semester

CS 644	**Computer Graphics**
Form of module	Lecture with Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56h (4 SWS)
	Self-study: 112h
Prerequisites	-
Aim of module	• Introduction to C/C++ • Ray Tracing • Lighting, Materials & Texturing • Spectral Analysis & Sampling Theory • Texture Filtering and Distribution Ray Tracing • Human Vision System, Color &HDR Imaging • Splines • Subdivision Surfaces • Camera Transformation and Clipping • Rasterization • Graphics APIs • Shader Programming • Shadow Algorithms • Volume Rendering
Learning outcomes and qualification goals	Expertise: • Get acquainted with the aims of the module (MK1, MK2, MF1, MF3)
	Methodological competence: • Programming of graphics applications (MF1, MF2, MF3)

	Personal competence: • Learn how to cope with a larger software project • Teamwork skills (MK01, MK02)
Media	Lecture slides, exercise sheets, project assignments, software, software documentation
Literature	• Steve Marschner and Peter Shirley, *Fundamentals of Computer Graphics*, 5th Edition, AK Peters, 2021 • Tomas Akenine-Möller et al., *Real-time Rendering*, 4th Edition, Taylor & Francis Ltd, 2018 • Matt Pharr and Greg Humphreys, *Physically Based Rendering*, 3rd Edition, Morgan Kaufmann, 2016 • John Hughes et al., *Computer Graphics: Principles and Practice*, 3rd Edition, Addison-Wesley, 2013 • Andrew S. Glassner, *An Introduction to Ray Tracing, 1st Edition*, Morgan Kaufmann, 1989
Methods	• Lecture • Weekly Exercises/programming projects
Form of assessment	Written examination (90 minutes)
Admission requirements for assessment	>=50% points in homework assignments in groups of 2-3 students
Duration of assessment	90 minutes written exam
Language	English
Offering	HWS 22
Lecturer	Junior Professor Dr. Roland Leißa
Person in charge	Junior Professor Dr. Roland Leißa
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 695	**Reinforcement Learning**
Form of module	Lecture with Exercise
Type of module	Specialization Course
Level	Master
ECTS	6
Workload	Hours per semester present: 56 (4 SWS)
	Self-study: 98h (70h lectures/exercises, 28h exam preparation
Prerequisites	Machine Learning / Computer Vision course, theoretical and practical knowledge of neural networks
Aim of module	- Basic concepts of reinforcement learning: MDP, policies, on-policy, off-policy learning - Classical tabular reinforcement learning, DP, Policy Iteration, Q-Learning, SARSA, Monte-Carlo methods - Function approximation for reinforcement learning - Policy gradient methods
Learning outcomes and qualification goals	Expertise: After the course students will understand classical concepts of reinforcement learning as well as state of the art algorithms.
	Methodological competence: The students are able to understand and customize popular reinforcement learning algorithms, choose the right setting for their problem and train agents to perform well in environments with which they interact.

	Personal competence: The course trains abstract thinking and the ability to formally model application scenarios. By solving assigned exercises independently, the transfer of the learned material to related questions is promoted.
Media	Exercise sheets and lecture slides available online, blackboard
Literature	- Sutton & Barto: Reinforcement learning: an introduction, 2018
Methods	Lecture, exercises every two weeks, book studies
Form of assessment	Written exam resp. Oral exam with smaller course size.
Admission requirements for assessment	-
Duration of assessment	Written: 90 min. Oral: 30 min.
Language	English
Offering	FSS
Lecturer	Prof. Dr. Paul Swoboda
Person in charge	Prof. Dr. Paul Swoboda
Duration of module	1 Semester
Further modules	
Range of application	Msc Business Informatics, Msc Data Science, Lehramt Informatik
Semester	1./2./3. Semester

D. Projects and Seminars

iii. Seminar

CS 722	**Seminar Ethical Aspects of Al**
Form of Module	Seminar
Type of Module	Seminar
Level	Master
ECTS	4
Workload	120 h per semester
Prerequisites	IE 661 / IS 661 "Text Analytics" or IE 675b "Machine Learning" or IE 678 "Deep Learning" or IE 560 "Decision Support"
Aim of module	In this seminar, students perform scientific research, either in the form of a literature review or by conducting a small experiment, or a mixture of both, and prepare a written report about the results. Topics of interest focus around a variety of problems and tasks from the fields of Data-Science, Network Science and Text Mining.
Learning Outcomes and Qualification Goals	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; presentation with PowerPoint or LaTeX.
Literature	Up-to-date literature will be assigned during the seminar.
Teaching and Learning Methods	Review scientific work independently under the guidance of a professor or a research staff member. Active discussions in a group of peers.
Form of Assessment	Written report with oral presentation
Admission requirements for assessment	-
Duration of Assessment	N/A
Language	English
Offering	Spring Semester
Lecturers	Markus Strohmaier, Simone Ponzetto
Person in charge	Markus Strohmaier, Simone Ponzetto
Duration of module	1 semester
Further modules	-
Range of Application	M. Sc. Wirtschaftsinformatik, M.Sc. Mannheim Master in Data Science, M. Sc. Mannheim Master Management
Semester	3rd semester