Module Descriptions Examination Regulations Master 2021

Project System Development

Module numbers:	36.4810 [Project System Development I 36.4806; Project System Development II 36.4808]
Language:	english
Study programme:	JIM 2013 - 3. Semester JIM 2006
Type of course:	Pro = Project
Weekly hours:	4 (per semester)
Credit Points:	15
Exam:	Evaluation of the presentation and the written presentation of the project results of the second semester; in addition to these two partial performances, the overall grade also takes into account the commitment and active participation during the entire project phase.
PVL (e.g. Practical):	Presentation and written presentation of the project results of the first semester (in what proportion these two partial performances will be included in the overall evaluation of PVL will be announced at the beginning of the project)
PVL percentage:	50%
Learning objectives:	Students are capable to • develop personal ethical and professional practices; to understand and apply a proven project management and quality assurance methodology; • develop abilities to comprehend and to negotiate user requirements and project specification; • develop abilities to perform high level feasibility analysis, risk analysis, economic analysis and ethical analysis, and high level design and synthesis skills; • develop personal professional project and time management practices; • develop interpersonal communication abilities including abilities to produce project reports, advertising flyers / posters and presentations. Generic skills to be taught • the ability to evaluate information • the ability to speak and write clearly, coherently and creatively • the ability to select and organize information and communicate it accurately, cogently, coherently, creatively and ethically • the ability to deploy critically evaluated information to practical ends • the ability to select and use appropriate tools and technologies • the ability to use online technologies effectively and ethically • the acquisition of coherent and disciplined sets of skills, knowledge, values and professional ethics from at least one discipline area • the ability to reflect on and evaluate learning, and to learn independently in a self directed manner

Content:	Projects involve the application of project management and problem-solving techniques to create and deliver custom IT/CS solutions to satisfy a client's needs. In particular the content of the course comprises the following components: • Clarification of the project, involving clear statements of problem identification, scope, rationale, audience and aims. • Description of the type of outcome required, including the nature of inputs and outputs, hardware and software requirements, further clarification of scope and performance requirements. Where appropriate, a survey of relevant literature. • Planning the management of the project development process, using a recognized Project Management methodology. This will typically include a high level design, a risk analysis, a cost analysis, a feasibility analysis, and a project plan/schedule. • Extending the high level design, and a feasibility analysis, into a detailed design • Implementation of the design with the chosen software and hardware. Testing performance by checking for logical and syntactical errors, and system performance against specifications. • Making judgments about the quality of the product, and the process of development including time management issues. Documentation of all phases of the project, together with manuals reports.
Literature:	will be announced at the beginning of the project
Lecture style / Teaching aids:	Presentation using the usual current media; scientific publications; project-related documents
Faculty:	Informatik
Responsibility:	Studiengangskoordinator Studiengang Joint International Master in Computer Science
Professional competencies:	• formal, algorithmic, mathematical competencies: depending on subject • analytical, design and implementation competencies: depending on subject • technological competencies: depending on subject • capability for scientific work: depending on subject
Interdisciplinary competencies:	• project related competencies: high • interdisciplinary expertise: the addressed areas depend on the topic • social and self-competencies: leadership competence, ability to work in a team, analytical competence, judging competence, deciding competence, competence of knowledge acquisition, presentational, documentary, teaching and mentoring competence

Advanced seminar

English Title:	Advanced Seminar
Document number:	41.4800
Language:	GERMAN
Assignment:	Master 2021 - 3rd semester Master 2013 - 3rd semester
Teaching Form:	S = Seminar
SWS:	2
CP:	5
Examination:	graded scientific paper of 10 to 20 pages and graded presentation and discussion of 45 to 60 minutes (the

	Both partial performances go in the ratio 70% (written elaboration) and 30 % (presentation and discussion) into the overall evaluation).
Evidence Requirement:	Achievements amounting to 20 CP from the master's program
Learning objectives:	The master's students will • acquire in-depth and specialized technical competencies in at least one subfield of computer science, • are able to independently compile relevant specialist literature on a specific complex of topics in computer science and to independently familiarize themselves with scientific publications, • can independently compose a scientifically sound written paper on a specific complex of topics in computer science, • are able to didactically design a lecture on a specific complex of topics in computer science and to give it using the usual media, • can contribute actively and in a well-founded manner to the discussion of specific complexes of topics in computer science.
Course Content:	Students are taught scientific publications on specific topic complexes of computer science provided. The knowledge and conclusions acquired during the literature research and study must be summarized in the form of a scientific paper and a presentation. Students must actively participate in the professional discussion of all presentations given during the seminar.
Literature:	Literature will be provided at the beginning of the seminar.
Forms of work / resources:	Lecture using the currently common media; scientific Publications
Department:	Computer Science
Module responsibility:	Program coordinator Master's degree program in Computer Science, General Master's variant.
Professional competencies:	Formal, algorithmic, mathematical competencies: depending on the Topic • Analysis, design and realization skills: depending on the topic • Technological competencies: depending on the topic • Ability to work scientifically: high
Cross-disciplinary competencies:	Cross-curricular competencies: the areas addressed depend on the Topic from • Social and personal competencies: Competence of analysis, competence of judgment, competence of knowledge acquisition, competence of presentation.

Project System Development

English Title:	Project System Development
Document numbers:	41.4806 [Systems Development I Project 41.4802; Systems Development II Project. 41.4804]
Language:	GERMAN
Assignment:	Master 2021 - 3rd semester Master 2013 - 3rd semester Master 2006
Teaching Form:	Pro = Project

SWS:	4 (per semester)
CP:	15
Examination:	Evaluation of the presentation and the written presentation of the project results of the second semester; in addition to these two partial performances, the commitment and the active participation during the entire project phase are also taken into account in the overall grade
PVL (e.g. internship):	Presentation and written presentation of the project results of the first (The ratio of these two partial performances to the overall assessment of the PVL will be announced at the beginning of the project).
PVL share:	50%
Learning objectives:	The master students are able to work on current practical and research-relevant issues from at least one subfield of computer science in a project team and to implement the results in practice. They expand and deepen • their professional competencies in at least one subfield of computer science, • their competencies in software engineering and project management, • their project-related competencies as well as their general transfer, social and personal competencies. Master's students will be able to apply these skills to the completion of a comprehensive project in the field of computer science.
Course content:	The topic of the project is based on current practical and research-relevant issues from at least one subfield of computer science.
Literature:	will be announced at the beginning of the project
Forms of work / resources:	Lectureusing the currently common media; scientific publications; project-related documents
Department:	Computer Science
Module responsibility:	Program coordinator Master's degree program in Computer Science, General Master's variant.
Professional competencies:	Formal, algorithmic, mathematical competencies: depending on the Topic • Analysis, design and realization skills: depending on the topic • Technological competencies: depending on the topic • Ability to work scientifically: depending on the topic
Supra-disciplinary competencies:	Project-related competencies: high • Cross-curricular competencies: the areas addressed depend on the subject matter • Social and personal competencies: Leadership competence, ability to work in a team, competence to analyze, competence to judge, competence to make decisions, competence to acquire knowledge, competence to present, to document, to teach and to advise.

Master Module

English Title:	Master Module
Document numbers:	41.6000 [master's thesis 41.6010; master's thesis IS 41.6011; master's thesis SE 41.6012; Master's thesis TG 41.6013; Master's thesis WI 41.6014; Colloquium 41.6020]

Language:	GERMAN
Assignment:	Master 2021 - 4th semester Master 2013 - 4th semester
Teaching Form:	Pro = Project
CP:	30
Examination:	graded final paper of 80 to 120 pages (more detailed information on the web pages of the FB I) and graded final colloquium (the two partial performances are included in the overall grade in the ratio 75% (final paper) and 25% (final colloquium)).
PVL (e.g. internship):	Creation ofthe poster on the content of the final thesis (more detailed information on the web pages of FB I).
Evidence Requirement:	Achievements amounting to 60 CP from the master's degree program; the Final colloquium can only take place when all achievements from the first study section have been completed (see § 7 para. 2 or 3 BBPO).
Learning objectives:	The master students are able to work independently and scientifically on a topic from a sub-field of computer science that is oriented towards scientific issues and is usually application-related. They will be able to summarize and precisely present the results achieved in compliance with the usual requirements for a scientific paper.
Forms of work / resources:	Lecture using the currently common media; scientific Publications
Department:	Computer Science
Module responsibility:	Program coordinator Master's degree program in Computer Science, General Master's variant.
Professional competencies:	Formal, algorithmic, mathematical competencies: depending on the Topic • Analysis, design and realization skills: depending on the topic • Technological competencies: depending on the topic • Ability to work scientifically: high
Supra-disciplinary competencies:	Project-related competencies: depending on the topic • Cross-curricular competencies: the areas addressed depend on the subject matter • Social and personal competencies: Analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, language competence, presentation competence.

Advanced Communication Networks

Module numbers:	41.4976 [PVL 41.4977]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Catalog AS: Application and system oriented modules JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and system oriented modules JIM 2006 - Courses Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization TC: Telecommunications

	Master 2006 - Specialization TS: Technical Systems Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+P = Lecture+Practical
Weekly hours:	3+1
Credit Points:	6
Exam:	written exam
PVL (e.g. Practical):	not graded (Conduct laboratory experiments, conduct projects, research, literature review, documentation, presentation.)
Required knowledge:	English language skills (understanding, speaking, reading, writing)
Learningobjectives:	The following competencies shall be established • Knowledge of fundamental structures and functions of packet-based telecommunication and data networks • Specifics of certain selected communication networks • Relationship to legacy telecommunication networks and services • Knowledge about the prevalent protocols, network and service functions • Analysis of such networks with an industry accepted tool set • Plan and evaluate packet-based networks • Readiness for the constant and fast changes in this field
Content:	The following topics shall be covered: • Requirements for large-scale telecommunication and data networks • Fixed and mobile access networks – Architectures – Transport technologies, e.g., DSL, DOCSIS, LTE – Used protocols, e.g., Ethernet, tunneling • Wide Area Networks (WAN) – Architectures – Employed protocols, e.g., MPLS – Local Area Networks (LAN) • Structure and function of selected network functions, e.g., – IP router – AAA-Function (e.g., RADIUS and DIAMETER) – Packet Gateways – and further as needed • Structure and function of Content Delivery Systems – Content Delivery Networks (CDNs) – Web-based service and content delivery – Exemplary content services: Web and Video on Demand • Structure of telecommunication networks – Network Operations (Operations Support System (OSS) and Business Support System (BSS)) – Operator peering – Virtualized networks – Software-Defined Networks • Introduction to traffic and operational analysis – Measuring and analyzing network traffic – Planning of networks • Advanced topics based on current research issues
Literature:	Internetworking with TCP IP, Comer • Computer Networks, Kurose & Ross • Data Network Technologies for Next Generation Networks, Obermann & Horneffer Further references will be given in the lecture.
Lecture style / Teaching aids:	Seminary lecture and practical training, current scientific and technical

	publications, practical training in the telecommunications laboratory
Faculty:	Computer Science
Expert group:	Telecommunications
Responsibility:	Martin Stiemerling

Current database technologies

English Title:	Current Trends in Database Technology
Document numbers:	41.4810 [PVL 41.4811]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization SE: Software Engineering Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization SE: Software Engineering Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Teaching form:	V+P = Lecture+Internship
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded (ungraded internship).
Required prior knowledge:	Architecture of database systems (not mandatory, but helpful) Learning
objectives:	Students will be able to • Be able to model geospatial data according to the Simple Feature Model or SQL/MM standard, • Be able to select an appropriate database management system for geospatial data storage and retrieval depending on the application context, • master the most important spatial operations according to the SQL/MM standard and • be able to select suitable index structures for geo-data to optimize queries, depending on the application context. The students should be able to use XML data in database systems for storage and retrieval depending on the application context. • Evaluate the advantages and disadvantages of different storage methods, • Select the most suitable storage methodology or database management system, and • Create and optimize database queries according to the SQL/XML standard. Students should • know the advantages and disadvantages of different storage and indexing methods for graph structures and • Be able to select, depending on the application context, an appropriate database management system for the storage and retrieval of

Select graph structures

Course content:

Presentation of specific application scenarios:
- Management of spatial data in DBS
- Management of XML in databases and generation of XML data from (relational) datasets
- Storage and retrieval of graph structures (e.g. for social graphs) in database systems

Consideration of
- Requirements for the DBMS derived from the specific application context
- special storage structures to support the requirements
- Extensions of the database query language to support the requirements (e.g. SQL/XML, SQL/MM Spatial) or specific database query languages for graph database systems

Literature:

Melton, Buxton: XQuery, XPath, and SQL/XML in Context, Morgan Kaufmann, 2006.
- Saake, Heuer, Sattler: Databases - Implementation Techniques, mitp, 2012
- Brinkhoff: Geodatabase systems in theory and practice, Wichmann, 2013
- Robinson, Webber, Eifrem: Graph Databases, O'Reilly & Associates, 2013

Recent Research Papers (VLDB, EDBT, BTW, etc.).

Forms of work / resources:

Seminar lecture
- Internship in groups of 2 people
- Resources: slides, research papers (original literature)

Department: Computer Science

Professional group: Databases

Module responsibility: Peter Muth

Subject Competencies:

Formal, algorithmic, mathematical competencies: medium
- Analysis, design and implementation skills: high
- Technological competencies: high (development process, strategic use of tools)
- Ability to work scientifically: weak

Supra-disciplinary competencies:

Project-related competencies: medium
- Cross-curricular subject competencies: Basic technical and scientific skills
- Social and personal skills: Analytical competence

Algorithmics

English Title: Algorithmics

Document numbers: 41.4964 [PVL 41.4965]

Language: GERMAN

Assignment:

CNAM - Master cycle
CNAM Master - Master cycle
Dual Master 2021 - Catalog T: Theory-oriented Modules
Master 2021 - Catalog T: Theory-oriented Modules
Dual Master 2013 - Catalogue T: Theory-oriented Modules
JIM 2013 - Elective Catalogue T
Master 2013 - Catalog T: Theory-oriented Modules
Master 2006 - Catalog T: Theory-oriented Modules
Master 2006 - Specialization CG: Computer Graphics

	Master 2006 - Specialization TS: Technical Systems MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Teaching form:	V+Ü = Lecture+Exercise
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. practical course):	ungraded (successful participation in the exercises: The preliminary examination performance has been achieved if 50% of the exercise problems have been worked on, correct solutions for two exercise problems have been presented during the exercise and a correct sample solution for one exercise problem has been worked out and handed in).
Learning Objectives:	The focus is on the following learning objectives: • Understanding of selected principles for the design of efficient algorithms • Knowledge of the implementation of these principles in the application area of algorithmic geometry. • Ability to analyze complicated algorithms in terms of their running time • Knowledge of basic approaches to dealing with difficult algorithmic problems and of the possibilities and limitations of such approaches.
Course Content:	Basic concepts – Algorithm runtime – Complexity measures, estimations • Principles of designing efficient algorithms – dynamic programming – Greedy algorithms – Divide & Conquer algorithms • Application area algorithmic geometry – efficient algorithms for selected problems (including underlying algorithmic principles and appropriate data structures; e.g. scan-line principle, geometric divide & conquer algorithms) • Dealing with difficult problems – P=NP? Problem – Heuristics (local search, branch & bound) – Approximation schemes In parallel to the lecture and tutorial, students work independently on the topic of randomized algorithms (with comprehension testing in an exam).
Literature:	Cormen, Th.H., Leiserson, Ch.E., Rivest, R., Stein, C.: Algorithms - An Introduction, 2nd edition, Oldenbourg Verlag, 2007. • Hromkovic. J.: Algorithmics for Hard Problems, 2nd Edition, Springer, 2003. • Klein, R.: Algorithmic Geometry, Springer 2005. • Schöning, U.: Algorithms, Spektrum-Akademischer Verlag, 2001.
Forms of work / resources:	Lecture, exercise to discuss exercises to be done at home. to be worked on; aids: transparencies, exercise sheets
Department:	Computer Science
Expert group:	Theoretical Computer Science
Module responsibility:	Steffen Lange
Subject Competencies:	Formal, algorithmic, mathematical competencies: high • Analysis, design and implementation skills: weak • Ability to work scientifically: medium

Cross-curricular competencies:	Cross-curricular competencies: Mathematical and basic scientific literacy

Applied Artificial Intelligence

Module number:	41.4990
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Catalog AS: Application and system oriented modules JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and System Oriented Modules Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	VP = Lecture with integrated Practical
Weekly hours:	6
Credit Points:	9
Exam:	oral exam
Required knowledge:	English language skills (understanding, speaking, reading, writing)
Learningobjectives:	The following competencies shall be established • Understanding of Artificial Intelligence (AI) as a discipline • Ability to classify certain project requirements as AI problems • Ability to select AI techniques for given AI problems • Ability to select state-of-the-art AI technology and tools for AI techniques to be implemented • Ability to model and design AI solutions using state-of-the-art AI technology and tools • Ability to implement AI solutions using state-of-the-art AI technology and tools
Content:	The following topics shall be covered. • Knowledge representation and ontologies • First-order Logic and reasoning, Probabilistic reasoning • AI application architecture • Agent technology • Natural language processing (NLP) • Information Retrieval • Computer Vision • Machine Learning Particular focus will be on the application of AI techniques, i.e., on how to build AI applications in practice. In the laboratory, students will gain practical project experience with AI technology and tools by implementing an AI application all together as a team. The application will include all topics presented in the lectures. Different AI technologies and tools will be evaluated and compared.
Literature:	Stuart Russell, Peter Norvig: "Artificial Intelligence - A Modern Approach" 3rd international edition. Pearson Education, 2010. (German edition: "Künstliche Intelligenz - Ein moderner Ansatz", 3rd updated edition). Marc Watson: "Practical Artificial Intelligence Programming with Java." http://www.markwatson.com/books/

Lecture style / Teaching aids:	Lecturewith workshop character, combined with internship with own notebooks; current publications; current tools, team work, Wiki.
Faculty:	Computer Science
Expert group:	Artificial intelligence
Responsibility:	Bernhard Humm

Approximation algorithms

English Title:	Approximation Algorithms
Document numbers:	41.4966 [PVL 41.4967]
Language:	GERMAN
Assignment:	CNAM - Master cycle CNAM Master - Master cycle Dual Master 2021 - Catalog T: Theory-oriented Modules Master 2021 - Catalog T: Theory-oriented Modules Dual Master 2013 - Catalogue T: Theory-oriented Modules JIM 2013 - Elective Catalogue T Master 2013 - Catalog T: Theory-oriented Modules Master 2006 - Catalog T: Theory-oriented Modules MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Teaching form:	V+Ü = Lecture+Exercise
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. practical course):	ungraded (successful participation in the exercises: The preliminary examination performance has been achieved if 50% of the exercise problems have been worked on, correct solutions for two exercise problems have been presented during the exercise and a correct sample solution for one exercise problem has been worked out and handed in).
Required prior knowledge:	Module Algorithmics
Learning Objectives:	The focus is on the following learning objectives: • Understanding of selected principles for the design of approximate algorithms • Ability to analyze in terms of the severity of an optimization problem. • Knowledge of approximate algorithms for different problem areas • Ability to analyze algorithms in terms of the goodness of the solutions they determine and their runtime.
Course content:	Basic terms – Approximation algorithms – relative approximation quality • Complexity theoretical basics – Complexity classes P and NP – NP-complete decision problems – NP-hard and strictly NP-hard optimization problems • Approximation algorithms with constant quality for selected optimization problems, among others from the following areas – Graph Theory – Process optimization • Approximation schemes

  - simple approximation schemes
  - complete approximation schemes
- Approximation algorithms of non-constant quality for selected graph-theoretic optimization problems
- Design technique linear programming
- Design technique randomization
  - Randomized algorithms
  - Randomized approximation algorithms and their derandomization.
- Limits of the approximability of optimization problems
  - Problems for which there are no approximation algorithms of constant quality
  - Problems for which there are no simple or complete approximation schemes

Literature:

Ausiello, G., Crescenzi, P., Gambosi, G., Kann, V., Marchetti-Spaccamela, A., Protasi, M.: Complexity and Approximation: Combinatorial Optimization Problems and Their Approximability Properties, Springer 1999.

- D. Hochbaum (Ed.): Approximation Algorithms for NP-Hard Problems, PWS Publishing Company, Boston, MA, 1997.
- J. Hromkovic: Algorithmics for Hard Problems: Introduction to Combinatorial Optimization, Randomization, Approximation and Heuristics, Texts in Theoretical Computer Science, Springer 2001.
- V. Vazirani: Approximation Algorithms, Springer 2001.
- R. Wanka: Approximation Algorithms, Teubner 2006.
- K. Jansen, M. Margraf: Approximative Algorithms and Nonapproximability, de Gruyter, 2008.

Work forms / resources: Detailed lecture notes (170 pages),slides

Department: Computer Science

Expert group: Theoretical Computer Science

Module responsibility: Steffen Lange

Subject Competencies:

Formal, algorithmic, mathematical competencies: high

- Analysis, design and implementation skills: medium
- Ability to work scientifically: medium

Cross-curricular competencies: Cross-curricular competencies: Mathematical and basic scientific literacy

Database systems architecture

English Title: Architecture of Database Systems

Document numbers: 41.5088 [PVL 41.5089]

Language: GERMAN

Assignment:

Dual Master 2021 - Catalog AS: Application and System-Oriented Modules
Dual Master 2021 - Specialization SE: Software Engineering
Master 2021 - Catalog AS: Application and System-Oriented Modules
Master 2021 - Specialization SE: Software Engineering
Dual Master 2013 - Catalog AS: Application and System-Oriented Modules
Dual Master 2013 - Specialization SE: Software Engineering
Master 2013 - Catalog AS: Application and System Oriented Modules
Master 2013 - Specialization SE: Software Engineering
MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.

Teaching form: V+P = Lecture+Internship

SWS:	2+2
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded (ungraded
internship)Learning Objectives:	Students should be able to • analyze the performance of database applications, • Analyze query plans and, based on that, optimize the physical design of the database, • Apply the most important ways of optimizing the performance of databases, • select the appropriate insulation level for the particular application, • practically apply backup and recovery procedures for databases and • Evaluate the main algorithms and data structures for implementing database systems in terms of their advantages and disadvantages.
Course Content:	Reference architectures for database systems. • Memory structures • Buffer management • Index structures • Request optimization • Transaction management and recovery • Distributed database architectures
Literature:	Härder, Rahm: Database Systems, Springer-Verlag, 2001. • Saake, Heuer, Sattler: Databases - Implementation Techniques, mitp, 2012 • Garcia-Molina, Ullman, Widom: Database Systems: The Complete Book, Prentice Hall, 2008 • Research papers (will be provided in lecture).
Forms of work / resources:	Seminar lecture • Internship in groups of 2 people • Resources: slides, research papers (original literature)
Department:	Computer Science
Professional group:	Databases
Module responsibility:	Peter Muth
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: high • Technological competencies: high (optimization strategies, development process) • Ability to work scientifically: weak Supra-disciplinary
competencies	: Project-related competencies: medium

Augmented and Virtual Reality

English Title:	Augmented and Virtual Reality
Document number:	41.5100
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization TG: Technical and Graphic Systems Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization TG: Technical and Graphic Systems

	Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphic Systems Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	VP = Lecture with integrated practical course
SWS:	4
CP:	6
Exam:	practical exam
Required prerequisites:	Computer Graphics (Bachelor 2014) or Visual Computing (Bachelor 2021), Computer Vision (Master 2021).
Learning Objectives:	Students will know the theoretical concepts and mathematical background on which any form of augmented reality exists. • They are trained in the use of different AR/VR display hardware, can use them and program them themselves. • Students will be familiar with different frameworks for creating AR and VR applications, be able to apply them and recognize their limitations. • They are also able to implement simple, location-stable AR applications or VR applications without framework support.
Course content:	Practically oriented familiarization with mathematical basics, camera sensor technology as well as stereo vision and 3D reconstruction. • For AR: Projective transformations and homographs • Generation and integration of 2D and 3D image content • Familiarization with various AR/VR frameworks such as AR-Core, AR-Kit, MRTK, Unity3D. • In the internship: conception and implementation of own AR/VR applications in small groups, with a focus on projection mapping, AR video augmentation, or VR headsets.
Literature:	Understanding Virtual Reality, 2nd edition, 2018, by William Sherman, Alan Craig, ISBN-13: 9780128183991 • Virtual and Augmented Reality (VR / AR): Fundamentals and Methods of Virtual and Augmented Reality, 2nd edition, 2019, by Ralf Dörner, Wolfgang Broll, Paul Grimm, Bernhard Jung, ISBN-13: 978-3662588604 • Augmented Reality, Theory and Practice, 2nd edition, 2014, by Anett Mehler-Bicher and Lothar Steiger, ISBN-13: 9783110353846.
Department:	Computer Science
Professional group:	Multimedia and graphics
Module responsibility:	Benjamin Meyer
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: high • Technological competencies: medium • Ability to work scientifically: weak
Supra-disciplinary competencies:	Project-related competencies: medium • Cross-curricular subject competencies: Basic technical and scientific skills • Social and personal skills: Ability to work in a team

Automotive Security

Document numbers:	41.5090 [PVL 41.5091; Module 41.50900]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching Form:	V+S+P = Lecture+Seminar+Internship.
SWS:	2+1+1
CP:	6
Exam:	Written exam
PVL (e.g. practical course):	graded (detailed elaboration in form of a conference paper)
Proportion PVL:	30%.
Required knowledge:	IT security, network security, cryptology
Learning Objectives:	Students will • Know the fundamentals of automotive systems, the relevant threats, and the challenges of implementing measures of the IT security and data protection • can systematically perform threat and risk analyses and derive appropriate security measures • can develop basic safety architectures for automotive systems using standard hardware and software mechanisms
Course content:	Overview of vehicles and attacks • Secure development process: threat and risk analyses, derivation of security measures (Threat Analysis, Risk Assessment, Risk Treatment) • Hardware security: Automotive Hardware Security Modules etc. • Software security: AUTOSAR classic, AUTOSAR Adaptive Platform, application security • Security mechanisms: Secure / Measured Boot, Remote Attestation, Secure Diagnostics, Over The Air (OTA) Update, Theft / Component Protection, Memory Protection Unit (MPU), Resource Isolation (memory, CPU etc.), Secure Storage, Secure Flashing etc. • Communication security of bus systems and automotive Ethernet: AUTOSAR Secure Onboard Communication (SecOC), MACsec, IPsec, TLS/DTLS • Vehicle2X communication security: IEEE 802.11p, Bluetooth, WiFi, 3G/4G/5G, OBD-2 • Safe electromobility: ISO/IEC 15118, OCPP etc. • Relevant standards and norms: ISO/SAE 21434, GDPR
Literature:	S. Checkoway et al. Comprehensive Experimental Analyses of Automotive Attack Surfaces. USENIX Security Symposium, 2011 • C. Miller and C. Valasek. A Survey of Remote Automotive Attack Surfaces. Blackhat, 2014 • K. Koscher et al. Experimental Security Analysis of a Modern Automobile. IEEE Symposium on Security and Privacy, 2010

- EVITA. Deliverable D3.2 - Secure on-board architecture specification. August 2011
- AUTOSAR specifications, e.g. Specification of Secure Onboard Communication
- ETSI specifications on Intelligent Transport Systems (ITS)
- Uptane: Securing delivery of software updates for ground vehicles, Whitepaper, 2021
- ISO/IEC 15118 Road vehicles - Vehicle-to-Grid Communication Interface
- ISO/SAE 21434 Road vehicles - Cybersecurity engineering
- ISO/IEC 11889: Trusted Platform Module
- Recent scientific publications

Work forms / resources:	Seminar lecture with practical and seminar / Lecture slides, further literature
Department:	Computer Science
Expert group:	IT Security
Module responsibility:	Christoph Krauß
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: medium • Technological competencies: medium • Ability to work scientifically: medium

Accompanied tutoring

English Title:	Accompanied Student-to-student Tutoring.
Document number:	41.4908
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog SSK: Social and Personal Skills Master 2021 - Catalog SSK: Social and Personal Skills. Dual Master 2013 - Catalog SSK: Social and Self Competences Master 2013 - Catalog SSK: Social and Self Competences
Teaching form:	V+P = Lecture+Internship
SWS:	1+2
CP:	2.5
Examination:	The examination is ungraded. In order to successfully complete this module, the following must be demonstrated: • Participation in the accompanying event • Successful tutoring activities (incl. 14-day office hours for or e-mail communication with internship participants). • Support in the preparation of sample solutions for the tasks to be worked on by the internship participants • Evaluation of the tutoring activities by the internship participants Tutoring must be positively evaluated by the professor on whose behalf the student is tutoring an internship group.
PVL (e.g., internship):	Participation in the accompanying event
Prerequisite:	PVL completed and written consent of the professor of FB I on whose behalf the master's student is to supervise an internship group as a tutor for a compulsory module in the study program of the bachelor's program in computer science, details:

	https://fbi.h-da.de/studium/studienorganisation/studienorganisation-m-sc-informatics/accompanied-tutorship
RequiredPrior knowledge:	Performance recordin the course in which the tutoring activity is to be carried out.
Learning objectives:	The master students acquire and expand the didactic competences essential for a tutoring activity in the field of computer science and apply them in the context of the tutoring activity. They moderate learning processes, lead discussions and conduct result-oriented conversations with learners and adequately apply didactic methods in their tutoring activities. During their tutoring activities, they are able to recognize the learning progress and deficits of the individual trainees, to perceive and appropriately take into account differences with regard to the level of knowledge, skills and abilities as well as cultural backgrounds.
Course Content:	In the accompanying lecture, the master's students are prepared for the Tutor activities are prepared and the relevant didactic concepts are introduced, explained and discussed. As part of the tutoring activity, they will supervise an internship group for a compulsory module in the bachelor's degree program in computer science.
Literature:	Literature for the accompanying course: • B. Hawelka, H. Hammerl, H. Gruber: Förderung von Kompetenzen in der Hochschullehre, Asanger Verlag, 2007. • H. Knauf, Tutoring Manual, Webler University Press, 2010. • N. Weicker, K. Thumser, Comprehensive didactic training of student multipliers, in: Neues Handbuch Hochschullehre, Raabe Verlag, 2005. Scripts and internship assignments for the corresponding compulsory module in the study program of the bachelor's degree program in computer science.
Work forms / resources:	Paper, white board
Subject area:	Computer Science
Module responsibility:	Dean of Studies
Interdisciplinary competencies:	Interdisciplinary subject-related competencies: Pedagogical-didactical Basic competence • Social and personal competencies: Analysis competence, judgment competence, decision-making competence, presentation, documentation, teaching and consulting competence.

Usable security

English Title:	Usable Security
Document numbers:	41.5092 [PVL 41.5093; Module 41.50920]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching Form:	V+S+P = lecture+seminar+practicum

SWS:	2+1+1
CP:	6
Examination:	Oral exam (30 minutes, with tasks from the master task catalog).
PVL (e.g., practicum):	grad(graded state-of-the-art report in the form of a conference paper on a topic/content of the lecture).
Proportion PVL:	33%
Learning Objectives:	Students will • know the challenges of the area of conflict between usability and information security • know alternative approaches for the implementation of protection goals of IT and information security • can apply procedure models for the development of usable and secure information systems and applications • can apply methods from the field of HCI to design, conduct and evaluate usability studies • can evaluate and assess information systems and applications with IT security functions in terms of usability
Course content:	Historical classification • Fundamentals of Human-Machine Interaction (HCI) • Process models and methods for the development of usable and secure information systems and applications • Methods for the design, implementation and evaluation of usability studies • Alternative methods for user authentication • Email security and usability • Interaction mechanisms and IT security policies • Security Awareness • Phishing attacks, detection and countermeasures • Secure, usable pairing of devices • Mobile Security and Privacy • Anonymity and privacy in networks • Privacy paradox
Literature:	S. Garfinkel, Usable Security, Morgan & Claypool, 2014. • H. Schmitt, P. Nehren, L. Lo Iacono, P. Gorski, Usable Security and Privacy by Design, Entwickler.press (2017). • L. Cranor, S. Garfinkel, Security and Usability: Designing Secure Systems that People Can Use, O'Reilly Media (2005). • J. Lazar, J. Feng, H. Hochheiser, Research Methods in Human-Computer Interaction, Morgan Kaufmann, 2017. • F. Sarodnick, H. Brau: Methods of Usability Evaluation: Scientific Foundations and Practical Application, Hogrefe 2016. • Recent Publications of the Symposium On Usable Privacy and Security, http://cups.cs.cmu.edu/soups/
Work forms / resources:	Lecture, script, scientific publications Department:
	Computer Science
Expert group:	IT Security
Module responsibility:	Andreas Heinemann
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: high • Technological competencies: medium • Ability to work scientifically: medium

Big Data Analytics

French title:	Bases de données avancées (2)
Document numbers:	41.4984 [NFE205; PVL 41.4985]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2021 - Specialization WI: Business Information Systems. Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization WI: Business Informatics Dual Master 2013 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Specialization WI: Business Informatics Master 2013 - Catalog AS: Application and System-oriented Modules Master 2013 - Specialization WI: Business Informatics Master 2006 - Catalog AS: Application- and System-oriented Modules Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Teaching form:	V+P = Lecture+Internship
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded
Required prior knowledge:	Basic statistics and programming skills are required. The prior or concurrent attendance of the courses "Data Mining (Fb I)" or "Data Mining 1 (Fb MN - Data Science)" and "Big Data Technologies" is recommended.
Learning Objectives:Students	will have an understanding of the growing complexity in the interplay of algorithms, business processes, and architectures in issues related to Analytics on Big Data. They are able to apply the strategically appropriate analysis methods for practical problems in the context of the overall architecture and suitable components for data management. You can extend existing system landscapes with components that are required for analytics on Big Data.
Course content:	(mining) algorithms on horizontally scaled data management. • The phases in the data science process - special features with regard to Big Data: – Data collection – Data cleansing – Data preparation, data transformation – Data visualization – Modeling, evaluation and deployment of the results • Machine learning techniques on large, distributed datasets: – Clustering – Classification – Dimension reduction • Stream Processing – Technological concepts – Processing guarantees – Descriptive statistics – Modeling and deployment - offline and online • Reference architectures in the area of Big Data • Large Scale Graphs – Patterns in graphs and graph generation

- Connected Components, Community Measures and Community Detection
- Graph partitioning and programming models

Literature:Current scientific publications at the time of the course, as well as:

- O'Neil, Cathy & Schutt, Rachel. Doing Data Science. O'Reilly 2014
- Agneeswaran, Vijay Srinivas. Big Data Analytics beyond Hadoop. Pearson 2014
- Nisbet, R., Elder J., Miner G. Handbook of Statistical Analysis & Data Mining Applications. Academic Press 2009
- Andrade, H.C.M., Gedik, B., Turaga, D.S. Fundamentals of Stream Processing. Cambridge University Press 2014
- Garofalakis, Gehke, Rastogi: Data Stream Management, Springer 2016
- Leskovec, Rajaraman, Ullman: Mining of Massive Datasets, Cambridge University Press, 2014.
- Marz, N., Warren, J., Big Data - Principles and best practices of scalable real-time data systems. Manning 2015
- D. Chakrabarti, C. Faloutsos. Graph Mining. Laws, Tools, and Case Studies.Morgan & Claypool Publishers 2012.
- R. Brath, D. Jonker. Graph Analysis and Visualization. Discovering business opportunity in linked data. Wiley 2015

Forms of work / resources: Seminar lecture, practical course in groups

Department: Computer Science

Professional group: Databases

Module responsibility: Markus Döhring

Subject Competencies: Formal, algorithmic, mathematical competencies: medium

- Analysis, design and implementation skills: medium
- Technological competences: medium ((development process, strategic use of tools, quality assessment of models and results))
- Ability to work scientifically: weak

Supra-disciplinary competencies: Project-related competencies: medium

- Cross-curricular subject competencies: Technical and scientific basic competence, economic basic competence
- Social and personal competencies: Analysis competence, judgment competence, decision-making competence.

Big Data Technologies

English Title: Big Data Technology

French title: Bases de données avancées

Document numbers: 41.4614 [NFE204; PVL 41.4615]

Language: GERMAN

Assignment: Dual Master 2021 - Catalog AS: Application and System Oriented Modules
Master 2021 - Catalog AS: Application and System Oriented Modules.
Dual Master 2013 - Catalog AS: Application and System Oriented Modules
Master 2013 - Catalog AS: Application and System Oriented Modules Master 2006 - Catalog AS: Application and System Oriented Modules
MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.

Teaching form: V+P = Lecture+Internship

SWS: 2+2

CP: 6

Exam:	Written exam
PVL (e.g. internship):	ungraded(internship + presentations of internship results)
RequiredPrevious knowledge:	Previousattendance of the course "Architecture of Database systems" is helpful, but not mandatory.
Learning Objectives:	Students should be familiar with technologies for processing BigData and their respective advantages and disadvantages. They should be able to select the appropriate technologies for practical problems.
Course content:	Technologies for storing and processing BigData • Distributed non-relational database systems ("NoSQL" database systems). – Architecture – Data partitioning and replication – Consistency and transaction concepts – Query languages and frameworks (incl. MapReduce) – Coexistence between SQL and NoSQL databases • Column-oriented databases – Architecture – Compression algorithms – Operator implementation – Optimization of database queries • In-memory databases – Architecture – Storage variants – Backup and restore techniques
Literature:	Brauer, Hampe, Edlich, Friedland, Brückner: NoSQL: Einstieg in die Welt nichtrelationaler Web 2.0 Datenbanken, Carl Hanser Verlag, 2nd ed. 2011 • Plattner, Zeier: In-Memory Data Management: Technology and Applications, Springer Verlag, 2nd edition, 2012. • Current research papers (VLDB and
SIGMOD)Work forms / resources:	Seminar-style lecture, practical course in
groupsDepartment:	Computer Science
Professional group:	Databases
Module responsibility:	Peter Muth

Biometric Systems

Module numbers:	41.5094 [PVL 41.5095; Module 41.50940]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Type of course:	V+S = Lecture+Seminar
Weekly hours:	2+2
Credit Points:	6

Exam:	written exam (90 min, with tasks from the master task catalog)
PVL (e.g. Practical):	graded (The PVL is achieved with the term paper, which will be graded based on the submitted paper and the oral presentation of the findings. The presentation will take place in the seminar).
PVL percentage:	50%
Required knowledge:	IT Security
Learning objectives:	After the course, the students should have acquired: • Knowledge about common statistical tools for biometrics • Insight into advantages and disadvantages of biometric characteristics • Understanding of multimodal biometrics • Knowledge of ethical and privacy issues in biometrics. • Understanding of the threats and protection mechanisms for biometric data • The ability to choose an appropriate biometric method for a given application area.
Content:	In this course, several key aspects of biometrics are covered. Lecture: The lecture begins with an overview of applied statistics and hypothesis tests as well as other common statistical tools for biometrics, and then covers selected biometric concepts, particularly fingerprint recognition, vein recognition, face recognition and iris recognition. To this end, the relevant physiological characteristics, their variability, and potential problems are discussed before analyzing different approaches for each of the attributes to be investigated. In each case, not only benign applications are covered but also potential bottlenecks such as insufficient sample quality along the entire processing chain. The use of multi-biometrics including data fusion is discussed both in the context of robustness against attacks and improving the overall accuracy of the recognition process. The course continues with a discussion of the ethical and privacy-related issues in biometrics, along with possible limitations and technical mitigation mechanisms. Special attention is given to privacy enhancing technologies that provides protection of sensitive biometric data. In this line the course concludes with comparison-on-card approaches and template protection concepts that allow revocation of biometric references. Seminar: The seminar will complement the topics of the lecture. The seminar will investigate application scenarios of biometrics in more detail. Further the student will have a chance to interact with current research projects. The student will provide a research report (term paper) on a topic that is chosen by the student in coordination with the lecturer.
Literature:	S. Li , A.K. Jain, Handbook of Face Recognition, Springer, (2011). • D. Maltoni, D. Maio, A. K. Jain, S. Prabhakar, Handbook of Fingerprint Recognition, Springer, (2009). • J. Wayman, A. Jain, D. Maltoni, D. Maio, Biometric Systems, Springer, (2005).
Faculty:	Computer Science
Expert group:	IT Security
Responsibility:	Christoph Busch
Professional competencies:	formal, algorithmic, mathematical competencies: medium • analytical, design and implementation competencies: high • technological competencies: medium • capability for scientific work: medium

Interdisciplinary competencies:	• project related competencies: low

Business Intelligence

Document numbers:	41.4822 [PVL 41.4823; Module 41.48220]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2021 - Specialization WI: Business Information Systems. Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization WI: Business Informatics Dual Master 2013 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Specialization WI: Business Informatics Master 2013 - Catalog AS: Application and System-oriented Modules Master 2013 - Specialization WI: Business Informatics Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Teaching form:	V+P = Lecture+Internship
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. internship):graded	(graded term paper and its presentation, ungraded internship) Proportion PVL: 50%.
RequiredPrevious knowledge:	Forstudents of computer science / business informatics the previous or accompanying attendance of the course "Data Mining" is strongly recommended.
Learning Objectives:	Students will • know the terminology and history of management support by methods and tools of business informatics and quantitative methods, they can classify them in the concepts of MIS, DSS, ESS and Business Intelligence. • know the necessary prerequisites (data procurement, data provision, -completion, clarification, etc.) and the technologies and approaches used for this purpose (DWH, data and text mining, statistical principles). • master the most important methods and procedures in the field of BI and can apply them (DWH structuring incl. ETL process, selected methods of data, text and web mining, key performance indicator systems, reporting, balanced score card approaches, operations research). • know the market of relevant software support and have exemplarily worked with one or more tools (BI Suite). • know exemplary applications and can present and explain the references to areas such as CRM, controlling, etc. and evaluate and apply appropriate methods and techniques in "new" application requirements. • Know the operational significance and dependencies of comprehensive BI solutions. • Are familiar with governance and alignment aspects as relevant to BI systems. • know the organizational necessities and structures of large BI solutions and can both plan and evaluate them.

Course Content:	Based on a broad understanding of business intelligence, the course will cover: • Definitions, delimitations, classifications • Historical developments, concepts, failures • Prerequisites: Data, data modeling, DWH including ETL, statistics, OR. • Data, text and web mining • Requirement analysis and conceptual design of a business intelligence system, differentiation into strategic and operational level • Applications in CRM, controlling, etc. and their consolidation/integration into a business intelligence system • Practical examples, case studies, systems relevant to the market, e.g. from SAP, etc. • Assessment of costs and benefits, determination of total cost of ownership • Variants of implementation (sourcing concepts such as SaaS and cloud computing) • Excursus: References to knowledge management
Literature:	Business Analytics, Issue No. 3, Volume 53, HMD ed. by K. Hildebrand, December 2016 and following issues of the HMD series, Springer Verlag, on BI topics. • Kemper, H. G.; Baars, H., Mehanna, W.: Business Intelligence & Analytics, Springer Vieweg, 4th edition, 2019, ISBN: 978-3834819581 • Mertens, P.; Griese, J.: Integrated Information Processing, Vol. 2; 10th edition Gabler, Wiesbaden, 2009, ISBN: 978-3834910011 • Bashiri, C., Engels, C., Heinzelmann, M.: Strategic Alignment, Springer, 2010, ISBN: 978-3642114373. • Gabriel, R. Gluchowski, P., Pastwa, A.: Data Warehouse & Data Mining, W3L-Verlag, 2011, ISBN: 978-3937137667 • Bachmann, R., Kemper, G.: Raus aus der BI-Falle, mitp-Verlag, 2011, ISBN: 978-3826691065 • Bauer, A., Günzel H.: Data Warehouse Systems: Architektur, Entwicklung, Anwendung, dpunkt.verlag, 4th edition, 2013, ISBN: 978-3898647854 • Inmon, W.H., Strauss, D., Neushloss, G.: DW 2.0: The Architecture for the Next Generation of Data Warehousing, Morgan Kaufmann, 2008, ISBN: 978-0123743190 • Kimball, R., Caserta, J.: The Data Warehouse ETL Toolkit, Wiley, 2004, ISBN: 978-0764567575. • Gluchowski, P., Chamoni, P.: Analytical Information Systems: Business Intelligence Technologies and Applications, Springer Gabler, 5th edition, 2016, ISBN: 973662477625. • Müller, R.M.., Lenz, H.: Business Intelligence, Springer Vieweg, 2013, ISBN: 978-3642355592 • various special and advanced books and articles of the technical literature especially on DWH and data mining methods, field reports, comparative studies.
Forms of work / resources:	Seminar-stylelecture, high proportion of interaction especially for practice and consolidation. In the practical course exemplary use of a BI tool (suite).
Department:	Computer Science
Professional group:	Information Systems
Module responsibility:	Arnim Malcherek
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: high • Technological competencies: medium (exemplary tool analysis and -evaluation of BI tools, exemplary use of BI tools) • Ability to work scientifically: medium

Cross-curricular competencies:	Cross-curricular subject competencies: Basic economic competence • Social and personal competencies: Analysis competence, judgment competence, decision-making competence.

Business Process Engineering

Document numbers:	41.5056 [PVL 41.5057; Module 41.50560]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2021 - Specialization WI: Business Information Systems. Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization WI: Business Informatics Dual Master 2013 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Specialization WI: Business Informatics Master 2013 - Catalog AS: Application and System-oriented Modules Master 2013 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	2+2
CP:	6
Examination:Written	exam
PVL (e.g. internship):	graded (preparation of a written paper and presentation, graded PVL (30% of the total grade))
PVL share:	30%
RequiredPrevious knowledge:	Basicin the field of business informatics according to the module "Introduction to Business Informatics", programming knowledge in Java, use of Maven as a build management system as well as git as a versioning system.
Learning Objectives:	Students will • understand the basic concepts of process-oriented companies • know operational scenarios in which information technology can be used advantageously • Understand the role of business process engineering as a connecting element between business strategy and implementation through IT systems and strengthening competitiveness • know the architecture of BPM solutions • can analyze, model, evaluate and simulate processes • can implement simple workflows with the help of a BPM tool • can independently analyze a scenario and present process improvements in a well-founded manner
Course Content:	Overview and goals of business process engineering (function-oriented vs. process-oriented company) • Notation languages (especially BPMN, DMN, CMMN, Petri nets) and approaches to modeling processes (value chain analysis, strategic vs. technical process models, business rules, business process patterns) • Use of process modeling tools • Analysis and simulation of business processes • Concepts and methods of Business Process Management • Process integration techniques (WebServices, Rest API, Spring Boot, Business Process Engine, analysis engines, task boards, dashboards) • Business Process Engineering in practice (e.g. Camunda BPM platform)

Literature:	Michael Hammer, James Champy: Reengineering the Corporation. A Manifesto for Business Revolution. Harper Business, New York, 1993 • Current OMG standards, see https://www.omg.org/spec/category/business-modeling/ • Jakob Freund and Bernd Rücker, Praxishandbuch BPMN: Mit Einführung in CMMN und DMN, Carl Hanser Verlag, 2016. • Jakob Freund and Bernd Rücker, Praxishandbuch BPMN: Mit Einführung in DMN, Carl Hanser Verlag, 2019 • Andreas Gadatsch, Basic Course in Business Process Management: Analysis, Modeling, Optimization and Controlling of Processes, Springer Vieweg, 2017. Additional literature and scientific articles will be announced in lecture.
Forms of work / resources:	Seminar-like lecture, small groups in the practical course, use of a Modeling and BPM tool , lecture hall exercises with supplementary examples, presentation slides.
Department:	Computer Science
Professional group:	Information Systems
Module responsibility:	Urs Andelfinger
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: high • Technological Competencies: medium ((Exemplary use of business process modeling tools, business process software solutions, as well as other current tools, if applicable, on the basis of a consistent task)) • Ability to work scientifically: medium
Supra-disciplinary competencies:	Project-related competencies: weak

Capture The Flag Hacking

Document number:	30.101Z
Language:	GERMAN
Assignment:	Bachelor - additional offer Bachelor dual KESS - additional offer Bachelor dual KITS - additional offer Bachelor dual KoSI - additional offer Bachelor KMI - additional offer Dual Master - additional offer JIM - additional offer KoSI - additional offer Master - additional offer
Teaching Form:	Pro = Project
CP:	0
Exam:	No exam
PVL (e.g., internship):	No PVL
Required previous knowledge:	Knowledge of programming, networks and operating systems, strong Interest in IT security
Learning Objectives:	Students will • learn about current security vulnerabilities

- acquire knowledge in dealing with Linux systems
- Understand security measures in web technologies
- understand assembly code applied in practice
- can exploit weaknesses in cryptographic procedures
- learn basic knowledge of various scripting languages (e.g. Python)

Teaching content: In the course, the team tries to exploit security vulnerabilities.

At the individual event dates, small teams are formed, which, depending on their own interests, acquire knowledge on the following topics through self-study:

- Cryptanalysis
- Reverse engineering
- Web security (SQL injections, buffer overflows)
- IT forensics (application forensics, steganography)
- Exploiting
- Attack documentation

On weekends, there are international competitions against other universities and hacker groups in which we participate.

Literature: https://ucs.fbi.h-da.de/category/ctf/

- Buchanan, Cameron; Kali Linux CTF Blueprints: Build, test, and customize your own Capture the Flag challenges across multiple platforms designed to be attacked with Kali Linux; Packt Publishing Ltd; 2014.

Work forms / resources: Thisis a voluntary work group, not a course. There is no grade or credit points for this.

Department: Computer Science

Expert group: IT Security

Module responsibility: Klaus Kasper

Chaos and fractals

English Title: Chaos and Fractals

Document numbers: 41.4826 [PVL 41.4827]

Language: GERMAN

Assignment: Dual Master 2021 - Catalog AS: Application and System Oriented Modules
Master 2021 - Catalog AS: Application and System Oriented Modules.
Dual Master 2013 - Catalog AS: Application and System-Oriented Modules
Dual Master 2013 - Specialization TG: Technical and Graphic Systems
Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems
Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization CG: Computer Graphics
Master 2006 - Specialization TS: Technical Systems
MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.

Teaching Form: V+SP = Lecture+Seminar/Internship

SWS: 2+2

CP: 6

Exam: Written exam

PVL (e.g. internship): ungraded (ungraded internship tasks incl. elaboration and ungraded presentation)

Learning Objectives:

Students will gain the ability to, among other things,

- understand and analyze dynamic systems as they occur everywhere in nature, technology and economy;
- Analyze, self-conceptualize, and implement self-organizing systems (e.g., structure and pattern formation, artificial life);
- generate natural-looking objects and object surfaces that cannot be modeled using standard computer graphics methods (e.g., plants and terrain shapes).

Students have in-depth knowledge of how to identify the critical areas where arbitrary dynamical systems can "turn" from order to chaos. Another focus is the distinction between "random" and "chaotic" system behavior.

Course content:

Determinism and deterministic chaos.

- Linear Iteration (Iterated Function Systems)
- Nonlinear iteration (quadratic and cubic iterator)
- Classics of chaos theory (escape-time methods: Mandelbrot set, Julia sets)
- Self-Organization (Cellular Automata)
- Strange attractors
- Generation of natural looking objects (e.g. plants and clouds)
- Fractal landscapes
- Chaos and numerics (e.g. error propagation, approximation methods)
- Measures of Chaos (Fractal Dimension, Lyapunov Exponent)
- Application areas of chaos theory (e.g. biology, physics, meteorology, economics, business administration, medicine, geomorphology).

Literature:

Barnsley M.: "Fractals Everywhere," Morgan Kaufmann, 2003.

- Deussen O., "Computer-generated plants"; Springer; 2003.
- Falconer K.: "Fractal Geometry: Mathematical Foundations and Applications", John Wiley, 2003.
- Frame F., Mandelbrot B., "Fractals, Graphics, and Mathematics Education," The Mathematical Association of America, 2002.
- John Johnston, "The Allure of Machinic Life: Cybernetics, Artificial Life, and the New AI," MIT Press, 2008.
- Miller F.P. et al: "Chaos Theory", Alphascript Publishing 2010
- Peitgen H.-O. et al.: "Chaos and Fractals", Springer, 2004.
- Peitgen H.-O., Richter P.H., "The Beauty of Fractals: Images of Complex Dynamical Systems", Springer 2012.
- Pritchard J.: "The Chaos Cookbook", Butterworth-Heinemann, 1996
- Prusinkiewicz P., Lindenmayer A.: "The Algorithmic Beauty of Plants", Springer, 2002.
- Wolfram St.: "A new Kind of Science", Wolfram Media, 2002

Work forms / resources:

seminarlecture, practical course and seminar printed and digital script, digital slide sets and exam examples, demo programs

Department:

Computer Science

Professional group:

Multimedia and graphics

Module responsibility:

Elke Hergenröther

Subject Competencies:

Formal, algorithmic, mathematical competencies: medium

- Analysis, design and implementation skills: medium
- Technological competencies: medium
- Ability to work scientifically: medium

Supra-disciplinary competencies:

Project-related competencies: medium

- Cross-curricular subject competencies: Basic technical and scientific competencies

- Social and personal competencies: Competence to analyze, competence to acquire knowledge

Cloud Computing Technologies

Module numbers:	41.4982 [PVL 41.4983]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Catalog AS: Application and system oriented modules JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and system oriented modules JIM 2006 - Courses Master 2006 - Catalog AS: Application and system oriented modules MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+P = Lecture+Practical
Weekly hours:	2+2
Credit Points:	6
Exam:	written exam (An oral exam might be chosen as an alternative to the written exam. The decision will be taken at the beginning of the term).
PVL (e.g. Practical):	not graded (Practical and presentation of internship results)
Required knowledge:	Knowledge in the fields of programming, operating systems and distributed systems
Learning objectives:	The students should get to know concepts and technologies from the field of Cloud Computing and be able to implement their application in a practical environment. They should get to know the informational aspects of cloud computing as well as the dependencies and influences and be able to take them into account during implementation.
Content:	Cloud computing concepts • Definitions and key terms • Application scenarios Cloud computing technologies • Cloud infrastructure and data center technologies • Virtualization and Containerization, like VMware ESX and Docker • Infrastructure-as-a-Service, like OpenStack • Platform-as-a-Service, like Kubernetes • Software as a Service • Serverless • Infrastructure as Code, like Ansible and Terrarform • CI/CD Ops and GitOps • Identity and access management, like Oauth, OpenID Connect, and Keycloak • Monitoring Cloud and Cloud applications, e.g. using Prometheus • Amazon Web Services, Google Cloud Platform, Microsoft Aszure • Security in cloud environments • Programming models like MapReduce
Literature:	Hwaiyu Geng: The Data Center Handbook. January 2015, Wiley • Betsy Beyer, Chris Jones, Jennifer Petoff, and Niall Richard Murphy: Site Reliability Engineering: How Google Runs Production Systems. • Kief Morris: Infrastructure as Code - Dynamic Systems for the Cloud Aged., January 2021, O'Reilly

- Yevgeniy Brikman: Terraform: Up and Running. 2019, O'Reilly
- Michael J. Kavis: Architecting the Cloud - Design Decisions for Cloud Computing Service Models (SaaS, PaaS, and IaaS), January 2014, O'Reilly
- Mike Julian: Practical Monitoring, 2017, O'Reilly
- Yevgeniy Brikman: Prometheus: Up and Running, 2018, O'Reilly
- Omar Khedher and Chandan Dutta Chowdhury: Mastering OpenStack, April 2017, O'Reilly

Lecture style / Teaching aids:	SeminaristicLecture, Internship in Groups
Faculty:	Computer Science
Expert group:	Operating systems / distributed systems
Responsibility:	Michael von Rüden
Professional competencies:	formal, algorithmic, mathematical competencies: low • analytical, design and implementation competencies: high • technological competencies: high • capability for scientific work: medium
Interdisciplinary competencies:	• interdisciplinary expertise: basic technical and natural scientific competence • social and self-competencies: analytical competence, judging competence

Cloud-native Application Engineering

Module numbers:	41.5052 [PVL 41.5053]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization SE: Software Engineering Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization SE: Software Engineering Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization SE: Software Engineering Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization SE: Software Engineering MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+P = Lecture+Practical
Weekly hours:	2+2
Credit Points:	6
Exam:	written exam
PVL (e.g. Practical):	not graded Precondition for completion of the PVL is the successful participation in the lab project. Further, it is required that each student gives a presentation on a specific aspect of the lab project. The presentation can be held individually or as a group. The topic for the presentation is picked by the students themselves. Possible topics may be, but are not limited to the following examples: • Design/Technology decisions taken during the development • Conceptual challenges encountered • Project fails discovered
Required knowledge:	Prior knowledge in the areas of programming, software engineering, cloud computing, database systems, and distributed systems. The cloud computing related knowledge can be acquired by taking the "Cloud Computing Technology" course offered by the department.
Learning objectives:	The students are able to build modern applications based on cloud infrastructure

	in real-world set ups. In order to do that students need to be taught how to architecture, design, and implement applications specifically for cloud deployment - cloud-native applications. To be more specific, students will be introduced to modern architectural styles that are well suited for the specific requirements of a cloud environment - these are foremost the microservices' and the serverless architectural styles. For students, to fully appreciate the unique application engineering challenges in the cloud bears, students need to understand the theoretical background and implications of cloud computing, horizontally scalable applications, statelessness, and their impact on the entire application life-cycle. Further, they need to understand the role of agile software engineering and DevOps for cloud-native application engineering.
Content:	cloud-computing/cloud-native-application-engineering-introduction • Architecture basics and what is different in the cloud – e.g. availability, resilience, scalability, statelessness • Application Architectures for the Cloud – e.g. 12-factor apps, service definition, service design, cloud architecture pattern, transaction management – e.g. microservices, serverless • Deployment Infrastructure and Application Life-cycle Management – e.g. agile software engineering, DevOps, quality management, release management • Data Architectures for the Cloud – e.g. Data persistence, Caching • Operational Architecture – e.g. Infrastructure-as-code – e.g. monitoring, logging, and alerting
Literature:	Newman, S., 2015. building microservices: designing fine-grained systems. " O'Reilly Media, Inc.". • Fowler, S.J., 2016. production-ready microservices: Building Standardized Systems Across an Engineering Organization. " O'Reilly Media, Inc.". • Kleppmann, M., 2017. Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. "O'Reilly Media, Inc. • Forsgren, N., Humble, J. and Kim, G., 2018. Accelerate: The Science of Lean Software and DevOps Building and Scaling High Performing Technology Organizations. • Kavis, M.J., 2014. architecting the cloud. Design decisions for cloud computing service models (SaaS, PaaS and IaaS)/Kavis MJ-Wiley. • Lewis, J. and Fowler, M., 2014. Microservices: a definition of this new architectural term. MartinFowler. com, 25. • Martin, R.C., 2017. clean architecture: a craftsman's guide to software structure and design. Prentice Hall Press. • Kim, G., Debois, P., Willis, J. and Humble, J., 2016. The DevOps handbook: how to create world-class agility, reliability, and security in technology organizations. IT Revolution
Faculty:	Computer Science
Expert group:	Software engineering
Responsibility:	Stefan T. Ruehl
Professional competencies:	formal, algorithmic, mathematical competencies: low • analytical, design and implementation competencies: high • technological competencies: high • capability for scientific work: low
Interdisciplinary competencies:	• project related competencies: high • social and self-competencies: ability to work in a team, analytical competence,

deciding competence, competence of knowledge acquisition, fluency

Coding theory

English Title:	Coding Theory
Document numbers:	41.4934 [PVL 41.4935]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog T: Theory-oriented Modules Master 2021 - Catalog T: Theory-oriented Modules. Dual Master 2013 - Catalogue T: Theory-oriented Modules JIM 2013 - Elective Catalogue T Master 2013 - Catalog T: Theory-oriented Modules Master 2006 - Catalog T: Theory-oriented Modules Master 2006 - Specialization IS: IT Security MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded (ungraded internship).
Learning Objectives:	Students will learn the algebraic principles and algorithms for constructing, encoding, and decoding codes. Students gain in-depth knowledge of the theory of linear codes. They are able to apply these practically to problems and are able to implement the algorithms in software. Furthermore, students learn about current research topics in coding theory.
Course content:	Source coding: optimal representation, Huffman coding. • Channel coding: error detection, error correction, block codes, maximum likelihood decoding, Hamming distance, minimum distance • Algebraic basics: finite bodies, prime bodies, extension bodies, arithmetic • Linear codes: Generator matrices, control matrices, isometrics, systematic coding, syndrome decoding. • Special constructions and barriers: dual code, Hamming code, simplex code, Reed-Muller code, majority logic decoding, Hamming barrier, singleton barrier, Griesmer barrier,Varshamov barrier • Cyclic codes: Polynomial coding, Reed-Solomon code, permutation decoding, Berlekamp algorithm. • Application examples: Compact Disc, NASA Spacecraft Codes • McEliece crypto system and Goppa codes
Literature:	Wolfgang Willems, Coding Theory, de Gruyter, 1999. • Anton Betten, Michael Braun, Harald Fripertinger, Adalbert Kerber, Axel Kohnert, and Alfred Wassermann, Error Correcting Linear Codes. Classification by Isometry and Applications, ACM 18, Springer, 2006. • Ralph-Hardo Schulz, Coding Theory: An Introduction, Vieweg, 2003. • W. Cary Huffman and Vera Pless, Fundamentals of Error-Correcting Codes, Cambridge University Press, 2003.
Work forms / resources:	Blackboard and presentation; programming and exercise
assignments Subject area:	Computer Science

Expert group:	Theoretical Computer Science
Module responsibility:	Michael Braun
Subject Competencies:	Formal, algorithmic, mathematical competencies: high • Analysis, design and implementation skills: medium • Technological competencies: medium (information theory and coding theory). • Ability to work scientifically: medium
Supra-disciplinary competencies:	Project-related competencies: medium • Cross-curricular subject competencies: Basic technical and scientific skills

Computer Forensics

English Title:	Computer Forensics
Document numbers:	41.4832 [PVL 41.4833]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security Master 2006 - Catalog AS: Application and System-Oriented Modules Master 2006 - Specialization IS: IT Security MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	3+1
CP:	6
Exam:	Written exam (90 min, with tasks from the master's task
catalog)PVL (e.g. internship):	ungraded(Successful participation in ungraded internship)
RequiredPrior knowledge:	Recommended: Basic knowledge of IT security
Learning Objectives:	Students will • Gain knowledge of general procedure models of digital forensics, be able to apply them (technically) and document them. • be able to analyze and evaluate unknown data carriers, program specifics and log files. • Be able to evaluate digital evidence and its legal relevance. • Be able to prepare expert opinions based on a case-based forensic analysis. • Be able to use and evaluate common tools in the field of digital forensics.
Course contents:	Procedure models, documentation, digital determination and expert opinion preparation. • Disk analysis (DOS/GPT partition scheme, HPA, DCO) • Advanced file system analysis (FAT, NTFS) incl. slack spaces • Application forensics (log files from firewalls/servers); basic programs such as browser, mail client, Instand Messenger • RAM analysis

- Hash functions in computer forensics
- Lectures by external speakers on current topics (e.g. integration via video conference)
- Independent development of material relevant to the examination on the topic "Role of hash functions in computer forensics".

Literature:

Brian Carrier: File System Forensic Analysis, 5th Printing. Addison-Wesley Longman, Amsterdam (March 17, 2005), ISBN 978-0321268174.

- Dan Farmer, Wietse Venema: Forensic Discovery. 2nd Printing. Addison Wesley, Boston et al. 2006, ISBN 0-201-63497-X, (Addison-Wesley professional computing series).
- Eoghan Casey (ed.): Handbook of computer crime investigation. Forensic tools and technology. Elsevier Academic Press, Amsterdam et al. 2009, ISBN 978-012374267-4.
- Alexander Geschonneck: Computer Forensics. Detecting, Investigating, Solving Computer Crimes. 5th updated and expanded edition. dpunkt Verlag, Heidelberg 2011, ISBN 978-3-89864-774-8.
- Keth Jones, Richard Bejtlich, Curtis Rose: Real Digital Forensics. Addison-Wesley Longman, Amsterdam; Edition: Pap/Cdr (October 6, 2005), ISBN 978-0321240699.
- BSI: Guideline 'IT Forensics', published by BSI in March 2011 (v 1.0.1)

Forms of work / resources: Lecture with accompanying practical course for deepening theoretical knowledge imparted.
The practical course is designed to deepen certain aspects of the course content in small working groups, e.g. analysis of applications and files on PC systems.
Resources: study letters / script, internet, laboratory equipment

Department: Computer Science

Expert group: IT Security

Module responsibility: Christoph Krauß

Professional competencies: Formal, algorithmic, mathematical competencies: weak.

- Analysis, design and implementation skills: medium
- Technological skills: high (digital discovery, disk and file system analysis, RAM analysis, application forensics, hash functions).
- Ability to work scientifically: medium

Supra-disciplinary competencies: Project-related competencies: medium

- Cross-curricular subject competencies: Basic technical and scientific skills
- Social and personal skills: Analysis competence, presentation, documentation, teaching and consulting competence.

Computer geometry

English Title: Computational Geometry

Document numbers: 41.5010 [PVL 41.5011]

Language: GERMAN

Assignment: Dual Master 2021 - Catalog T: Theory-oriented Modules
Master 2021 - Catalog T: Theory-oriented Modules.
Dual Master 2013 - Catalog T: Theory-oriented Modules
Master 2013 - Catalog T: Theory-oriented Modules
MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.

Teaching Form: V+S+P = Lecture+Seminar+Internship.

SWS:	2+1+1
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded ungraded internship assignments incl. elaboration as well as ungraded presentation in the seminar
Required Prior Knowledge:	Graphic Data Processing
Learning Objectives:	Students will gain the ability to, among other things, • Design and realize 2D and 3D constructions from the graphic data processing and CAD. • Design and implement transformation sequences as used in graphical computing, CAD, and robotics. • Perform investigations on geometric conditions such as those encountered in graphical DP, CAD, and robotics. In this context, students have in-depth knowledge of transferring and applying geometric design, transformation and analysis principles to special tasks in 2D and 3D geometry.
Course content:	Homogeneous coordinates (construct, transform, analyze). • Conformal Geometric Algebra (construct, transform, analyze) • Special constructions and representations; (e.g. convex hull, triangulation, mesh generation). • Special rotation techniques for motion interpolation using quaternions. • Projections; (perspective transformation and projection, parallel projections). • Extreme objects; (e.g. bounding boxes, bounding spheres) • Direct and Inverse Kinematics • Interaction and search; (e.g. collision detection, area search). • Neighborhood investigations; (e.g. closest neighboring point pair, closest point, Voronoi diagram incl. dualism to the Delaunay triangulation) • Parametric space curves and surfaces; (e.g. Bezier curves, splines). • alternative modeling methods; (e.g. sweeping, constructive solid geometry)
Literature:	Rosenbaum U.; "Projective Geometry"; Vieweg 2004 Perwass Chr.; "Geometric Algebra with Applications in Engineering"; Springer 2009 Hildenbrand D.; "Foundations of Geometric Algebra Computing"; Springer 2013 De Berg M. et al; "Computational Geometry: Algorithms and Applications"; Springer 2008. Klein R.; "Algorithmic Geometry: Fundamentals, Methods, Applications"; eXamen.press 2005. Foley J. D. et al; "Computer Graphics: Principles and Practices"; Addison-Wesley 2013. Salomon D.; "Curves and Surfaces for Computer Graphics"; Springer 2006.
Forms of work / resources:	Lecture + practical + seminar; Digital slide sets, examples via visualizer and demo programs
Department:	Computer Science
Expert group:	Theoretical Computer Science
Module responsibility:	Elke Hergenröther
Subject Competencies:	Formal, algorithmic, mathematical competencies: high

- Analysis, design and implementation skills: medium
- Technological competences: medium ((development of efficient algorithms for 2D and 3D geometry))

Supra-disciplinary competencies: Project-related competencies: medium

- Cross-curricular subject competencies: Basic technical and scientific skills
- Social and personal skills: Ability to work in a team, analytical competence, competence to acquire knowledge, presentation, documentation, teaching and consulting competence.

Computer graphics

English Title:	Computer Graphics
Document numbers:	41.4834 [PVL 41.4835; Module 41.48340]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphic Systems Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization CG: Computer Graphics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	2+2
CP:	6
Exam:	Written exam
PVL (e.g., internship):	Graded (graded technical presentation including demonstration of the developed Application software and four- to six-page scientific paper).
PVL share:	50%
RequiredPrior knowledge:	Basic knowledge in Graphical Data ProcessingLearning
objectives:	Students will be exposed to different reflection and know illumination methods, have understood the basic calculations and can implement them so that they can program methods derived from ray tracing. Furthermore, they can simulate different material properties and surface structures. • They are to use mapping techniques, such as those used to simulate Real-time lighting used, know. • They should be able to calculate projections from 3D to 2D and know, classify and partially derive advanced geometric transformations. • Students should be familiar with methods for size-, shape- and color-accurate perception. In particular, they should be familiar with the CIE system and be able to perform the conversion from the 3D model to the 2D normal color system to be derived. • They should know techniques and various types of stereo projection and be able to design their own projections.
Course content:	Reflection and illumination models (incl. physical basics for the

Reflection calculation)
- Methods for physical illumination simulation (various ray tracing methods including photon mapping)
- Mapping techniques (e.g. methods for illumination simulation)
- Real time lighting simulation method
- Advanced geometric methods, for example, for the projection and transformation of objects.
- Procedure for size-, shape- and color-true perception (incl. perception per se)

Literature:

Foley J., van Dam A. et al. " Introduction to Computer Graphics", Addison Wesley, 1994.
- Nischwitz A., Haberäcker P. "Master Course Computer Graphics and Image Processing", Vieweg Verflag, 2004.
- Akenine-Möller T. "Haines E., Real-Time Rendering" A K Peters, 2003.
- Pharr, M., Humphreys, G. "Physically Based Rendering," Elsevier, 2004.
- as well as various ACM and IEEE publications

Forms of work / resources:

Seminar lecture, practical course with lecture presentation and Demonstration of end-of-semester lab assignments, digital slide sets, and exam examples.
- During the internship, students work in teams of two or Groups of three into a topic that is only indirectly related to the lecture material.
- A literature review, a demonstrator, a scientific paper by four to six pages are to be prepared and the results presented in a paper.

Department: Computer Science

Professional group: Multimedia and graphics

Module responsibility: Elke Hergenröther

Subject Competencies:

Formal, algorithmic, mathematical competencies: medium
- Analysis, design and implementation skills: medium
- Technological competencies: medium (physically based rendering, real-time lighting simulation, CIE system, affine and projective geometry).
- Ability to work scientifically: high

Supra-disciplinary competencies:

Project-related competencies: medium
- Cross-curricular subject competencies: Basic technical and scientific skills
- Social and personal skills: Ability to work in a team, analytical competence, competence to acquire knowledge, presentation, documentation, teaching and consulting competence.

Computer Vision

Document numbers: 41.5048 [PVL 41.5049; Module 41.50480]

Language: GERMAN

Assignment:

Dual Master 2021 - Catalog AS: Application and System-Oriented Modules
Dual Master 2021 - Specialization TG: Technical and Graphic Systems
Master 2021 - Catalog AS: Application and System-Oriented Modules
Master 2021 - Specialization TG: Technical and Graphic Systems
Dual Master 2013 - Catalog AS: Application and System Oriented Modules
Dual Master 2013 - Specialization TG: Technical and Graphical Systems
Master 2013 - Catalog AS: Application and System Oriented Modules

	Master 2013 - Specialization TG: Technical and Graphical Systems MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	2+2
CP:	6
Exam:	Written exam (90 minutes)
PVL (e.g. practical course):	graded(lecture with colloquium and demonstration of the
software) Proportion PVL:	50%.
Required Prior Knowledge:	Basic knowledge of graphic data processing
Learning Objectives:	Students will gain the ability to use computer vision systems as they are e.g. in medicine, manufacturing automation, robotics and autonomous driving, and to analyze them • Students will be able to understand the basics of artificial vision • You will acquire the ability to design and implement computer vision systems yourself as well as to select camera systems and design and implement procedures for calibration • They can explain and implement essential methods for feature extraction, segmentation and object recognition. Building on this, students acquire in-depth knowledge of automated near-real-time stereo image and image sequence evaluation. • You can understand, apply and adapt current AI-based methods
Course content:	Visual perception in humans versus computer vision. • Sensors, cameras and optical images • Comparison of pictorial information (image difference, image correlation) • Basics of segmentation and feature extraction • Stereo image evaluation (obstacle detection, 3D evaluation) • Image sequence analysis (change detection, relative distance, motion and collision prediction, optical flow) • Deep Learning approaches (e.g. RNN and CNN resp.R-CNN). • Shape from X (3D shape from lighting - photometric stereo, 3D shape from contours, 3D shape from textures) • Application examples
Literature:	Burger W., Burge M.J., "Principles of Digital Image Processing", Springer, 2010. • Demant C., Streicher-Abel B., Waskewitz P., "Industrial Image Processing ", Springer, 2011. • Forsyth D. A., Ponce J., "Computer Vision", Prentice Hall, Pearson Education, 2012. • Goldstein E. B., "Perceptual Psychology", Spektrum Akademischer Verlag, 2015. • Gonzales R., Woods R., "Digital Image Processing", Addison Wesley, 2018. • Jähne B., "Digital Image Processing and Image Acquisition" , Springer, 2012. • Nischwitz A. et al, "Computer Graphics and Image Processing: Volume II: Image Processing: 2", Vieweg+Teubner, 2011. • Russ J. C., "The Image Processing Handbook", Springer, 2011. • Szeliski R., "Computer Vision- Algorithms and Applications", Springer, 2011. • Goodfellow I., Bengio Y., Courville A, "Deep Learning", MIT Press, 2016.
Work forms / resources:	seminar lecture, project, digital slide sets and exam examples, demo programs
Department:	Computer Science

Professional group:	Multimedia and graphics
Module responsibility:	Elke Hergenröther
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: medium • Technological competencies: medium • Ability to work scientifically: medium
Supra-disciplinary competencies:	Project-related competencies: high • Cross-curricular subject competencies: Basic technical and scientific competencies • Social and personal competencies: Analytical competence, competence to acquire knowledge, presentation, documentation, teaching and consulting competence, language competence.

Cryptography

Module numbers:	41.4936 [PVL 41.4937]
Language:	english
Study programme:	Dual Master 2021 - Catalog T: Theory-oriented modules Master 2021 - Catalog T: Theory-oriented modules Dual Master 2013 - Catalogue T: Theory-oriented Modules JIM 2013 - Elective Catalogue T Master 2013 - Catalog T: Theory-oriented modules JIM 2006 - Courses Master 2006 - Catalog T: Theory-oriented Modules Master 2006 - Specialization IS: IT Security MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+Ü+P = Lecture+Exercise+Practical
Weekly hours:	2+1+1
Credit Points:	6
Exam:	written exam
PVL (e.g. Practical):	not graded (ungraded practical course and participation in the exercises)
Requiredknowledge:	Desirable: Cryptology from the Bachelor's program
Learning objectives:	After this course the students • have an understanding of different security terms in cryptography. • have knowledge of the significance of probabilities and entropy for the security of cryptographic schemes. • understand the fundamental principles of quantum cryptography. • know that alternative cryptographic schemes like elliptic curve based procedures exist and how to apply them in practice. • are able to choose suitable parameters for cryptographic schemes. • evaluate the security of pseudo random numbers and stream ciphers. • have knowledge of implementation aspects of cryptography and are able to apply this knowledge in practice. • are able to decide about the zero-knowledge property of a cryptographic protocol.
Content:	Information theory (terms, probability, Shannon's theorem). • Entropy • Design principles of cryptographic hash functions • Fundamentals of quantum cryptography • A sketch of RSA and Elliptic curve cryptography

- Pseudo random number generators and stream ciphers
- Implementation issues (efficiency, obfuscation)
- Practical solutions to exercises

Additionally: Autonomous acquisition of zero knowledge protocols, which will be treated in the exam.

Literature: Nigel Smart: Cryptography. Mcgraw-Hill Professional, 2002
- Alfred Menezes, Paul van Oorschot, Scott Vanstone: Handbook of Applied Cryptography, CRC Press, 1996
- Bruce Schneier: Applied Cryptography, John Wiley & Sons, 1995
- Further current literature is mentioned in the lecture.

Lecture style / Teaching aids: Seminaristiclecture + practical course + exercise (half of the practical course consists of theoretical exercises)

Faculty: Computer Science

Expert group: Theoretical computer science

Responsibility: Alex Wiesmaier

Professional competencies: formal, algorithmic, mathematical competencies: high
- analytical, design and implementation competencies: high
- technological competencies: medium (Dealing with cryptographic libraries (e.g. openssl), concealment methods for securing the private key, efficient implementations)
- capability for scientific work: medium

Interdisciplinary competencies:
- project related competencies: low
- interdisciplinary expertise: basic technical and natural scientific competence

Culture and Language I

Module number: 36.4802

Language: english

Study programme: Dual Master 2021 - Catalog SSK: Social and personal competences
Master 2021 - Catalog SSK: Social and personal competences
Dual Master 2013 - Catalog SSK: Social and personal skills JIM 2013 - 2nd semester.
Master 2013 - Catalog SSK: Social and personal competences JIM 2006 - Language and Culture
Master 2006 - Electives outside the study program

Type of course: S = Seminar

Weekly hours: 4

Credit Points: 5

Exam: graded homework, graded presentation and oral examination, which are included in the overall grade at a ratio of 50%, 20% and 30% respectively

PVL (e.g. Practical): Continuous participation

Requiredknowledge: onlyfor students of the Master's programme in Computer Science: English at a level that allows active participation in discussions and enables the preparation and presentation of the term paper

Learning objectives: The students shall:
- become more adapted and comfortable in using English in classroom situations
- learn about what makes Americans and Australians "tick" - and how do

	Germans "tick • become sensitive to areas where cultural differences can be critical and • learn how to handle them • become more familiar with cultural diversity in general and specifics of the country they will be studying in • become familiar with the English language not only as a "technological language" but as a way to communicate feelings and emotions • understand that "small talk" is considered an art in the countries they will be studying in • learn about the way society and government are organized in order to profit as fully as possible from the semester abroad
Content:	Comparison of government systems and economies: Germany/U.S.A./Australia. Choice of subject for presentation and paper. Insights into culture in target countries. Social structures and inter-personal relationships. If the course is offered two times (for other master students than JIM) the range of countries is broadened.
Literature:	Texts and articles are distributed or named by the teacher at the beginning of the course.
Lecture style / Teaching aids:	seminaristic lecture, literature work,presentation
Faculty:	Social Sciences
Expert group:	Social and cultural aspects of computer science
Responsibility:	Program Coordinator Joint International Master in Computer Science Program
Interdisciplinary competencies:	• interdisciplinary expertise: basic economic competence, Competences of scientific work from an interdisciplinary point of view • social and self-competencies: deciding competence, fluency, social and political competence

Data preprocessing and feature engineering

English title:	Data preparation and feature engineering
Document numbers:	41.5084 [PVL 41.5085]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and system-oriented modules Master 2013 - Catalog AS: Application and system-oriented modules MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Teaching form:	V+P = Lecture+Internship
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded
Prerequisite knowledge:	Statistics fundamentals, data mining fundamentals, programming, databases
Learning objectives:	Students will. • Be able to strategically and semantically evaluate and apply methods of (statistical) data preparation for mining procedures, • Learn important procedures of data mining feature engineering,

	evaluate and be able to apply them strategically, • Understand the underlying machine learning methods to the extent that the possible feature representations can be optimally applied to the corresponding algorithms,
Course content:	methodologies for carrying out the preparatory processes of the – Data understanding, – data preparation (including integration of different data sources, data profiling, data cleansing, elimination of inconsistencies, handling of missing values, noisy data, etc.), – of feature engineering (e.g. data cleansing, feature selection, feature reduction, feature construction & extraction, feature transformation, feature sampling) – as well as the modeling and parameterization for the application of the selected mining methods. • The underlying mathematical methods of the different algorithmic solution approaches are elaborated.
Literature:	Garcia: Data Preprocessing in Data Mining, Springer, 2014. • Ozdemir, Susarla: Feature Engineering Made Easy: Identify unique features from your dataset in order to build powerful machine learning systems, Packt Publishing, 2018. • Zheng, Casari: Feature Engineering for Machine Learning Models: Principles and Techniques for Data Scientists, O'Reilly, 2018. • Kuhn, Johnson: Feature Engineering and Selection: A Practical Approach for Predictive Models, Taylor & Francis, 2019. • Research papers (will be provided as part of the lecture).
Forms of work / resources:	seminar lecture • Internship in groups of max. 2-4 students, application of mining tools within the framework of the internship. • Resources: slides, research papers
Department:	Computer Science
Expert Group:	Data Science
Module responsibility:	Markus Döhring

Didactics of computer science

English Title:	Didactics of Information Technology
Document numbers:	41.4910 [PVL 41.4911; Module 41.49100]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog SSK: Social and Personal Skills Master 2021 - Catalog SSK: Social and Personal Skills. Dual Master 2013 - Catalog SSK: Social and Self Competences Master 2013 - Catalog SSK: Social and Self Competences Master 2006 - Catalog S: Interdisciplinary Key Qualifications
Teaching Form:	S = Seminar
SWS:	4
CP:	5
Exam:	Presentation (teaching sample)
PVL (e.g. internship):	graded (course-related evaluation of lecture, lesson outline and evaluation).

PVL share:	50%
Learning Objectives:	Students will • know basic didactic models, • Be able to plan IT training roughly and in detail, • Be able to conduct IT training, • Be able to evaluate IT training.
Course Content:	Theory of instructional design • Overall planning of a course • Detailed planning of a course unit • Implementation of a course unit • Evaluation of a course unit or course
Literature:	Rüdiger Baumann: Didaktik der Informatik, 2nd edition, Klett 1996. • Stefanie Gerlach et al: Methodenhandbuch für Softwareschulungen, Springer Berlin, 2004. • Peter Hubwieser: Didaktik der Informatik, 3rd edition, Springer 2007. • Ludger Humbert: Didaktik der Informatik, 2nd edition, Teubner 2006. • Sigrid Schubert, Andreas Schwill: Didaktik der Informatik, Spektrum
2004.Work forms / resources:	Lecture, discussion, group work, practical project; video
recordingsDepartment:	Computer Science
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Ute Trapp
Supra-disciplinary competencies:	Project-related competencies: medium • Interdisciplinary competencies: Basic pedagogical and didactical competencies • Social and personal competencies: presentation, documentation, teaching and consulting skills

Embedded HMI & Graphics

Document numbers:	41.5032 [PVL 41.5033]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization TG: Technical and Graphic Systems Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization TG: Technical and Graphic Systems Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphic Systems Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	2+2
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded (predefined number of internship tests taken)Learning
objectives:	Learning objectives are the handling of HMI and graphics frameworks
and own	Implementation experience in developing user-friendly applications on embedded systems with graphical display. At the end of the course, students will be able to develop embedded HMI applications for embedded

	Linux as well as create graphics-oriented apps on Android or iOS. You know the commonly used patterns. You have used compositors and can handle the graphics frameworks OpenGL-ES and QT. You know typical constraints for the development of ergonomic applications in the embedded environment and are able to accompany schematic reviews from a software point of view and to integrate new displays into an embedded system from a software point of view.
Teaching content:	Control of displays in embedded systems. • Requirements and methods of user-friendly application development for typical embedded environments (driver's workplace, smartphone) • Programming graphical applications with QT • Programming graphical applications with Open GL ES • Development under embedded Linux as well as Android or iOS and use of the operating system specific compositors
Literature:	OpenGL ES 2.0 Programming Guide;Munschi, Ginsburg, Shreiner; Addison Wesley, 2009. • OpenGL SuperBible, Sixth Edition, 2014 • http://doc.qt.io • Automotive Embedded Systems; Wietzke, Tran; Springer Verlag, 2005 • Real-Time Systems and Programming Languages; Burns, Wellings; Addison-Wesley, 2001. • Real-Time Design Patterns; Douglas; Addison-Wesley, 2003. • Embedded Technologies; Wietzke, Springer Verlag, 2012 • Script
Forms of work / resources:	Lecture, blackboard exercises, practicals, possibly small lectures, team
projects Department:	Computer Science
Expert group:	Computer Engineering
Module responsibility:	Stefan Rapp
Professional Competencies:	Analysis, design and implementation competencies: high • Technological competencies: high • Ability to work scientifically: weak
Cross-curricular competencies:	Cross-curricular competencies: Technical and basic scientific literacy

Ethics and computer science - values in technical action

English Title:	Ethics and Computer Science
Document number:	41.4918
Language:	GERMAN
Assignment:	Master 2021 - Catalog SWK: Social Science Competencies Master 2013 - Catalog SWK: Social Science Competencies Master 2006 - Catalog S: Interdisciplinary Key Qualifications.
Teaching Form:	S = Seminar
SWS:	2
CP:	2.5
Examination:	Presentation with thesis paper and, if applicable, short written paper (will be announced in the first course).
PVL (e.g., internship):	Continuous attendance, willingness to discuss

Learning objectives:The	aim of the seminar is to learn and practice strategies for perceiving, assessing and solving problems in technology ethics on the basis of current and professionally relevant case studies. Students should • Learn general principles of ethics as well as specifically professional ethics, • learn to develop an ability to perceive ethics-relevant problem situations, • Be able to analyze case studies of given sociotechnical problem situations in depth using different concepts of ethics, • Learn to evaluate and assess individual, social, and institutional actions in sociotechnical situations, • Practice strategies for problem solving case studies by applying ethics concepts.
Course content:	Computer science terminology, ethics, professional ethics. • Ethics in technical civilization • Ethics and codes of ethics in technical professions • Individual and institutional ethics • Codes of ethics for computer scientists • ethical conflicts • Case studies
Literature:	Lenk, H.; Ropohl G. (eds.), 1993: Technology and Ethics, Stuttgart. • Grunwald, A., 2010: Technikfolgenabschätzung; 2nd ed. • Hausmanninger, T.; Capurro, R., 2002: Netzethik. Basic Questions of Internet Ethics, Munich. • Kuhlen, R., 2004: Informationsethik; Konstanz. • Stamatellos, G. , 2007: Computer Ethics. A global perspective, Sudbury • Stoecker, R. et al. (Eds.), 2011: Handbuch Angewandte Ethik;
StuttgartForms of work / resources:	Seminar with integrated lecture parts
Department:	Computer Science
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Jan Schmidt
Supra-disciplinary competencies:	Project-related competencies: weak • Interdisciplinary competencies: Social science, ethical and philosophical basic competencies, basic competencies in the theory of science, competencies in scientific work in a field outside the subject area. • Social and personal competencies: Ability to work in a team, analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence.

Formal conceptual analysis

English Title:	Formal Concept Analysis
Document numbers:	41.4958 [PVL 41.4959; Module 41.49580]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and System-oriented Modules

	Master 2013 - Catalog AS: Application and system-oriented modules Master 2006 - Catalog AS: Application and system-oriented modules MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+Ü = Lecture+Exercise
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. practical course):	graded (graded written exam, compulsory attendance at all
exercises) Proportion of PVL:	50%.
Required prerequisite courses:	Basic knowledge of mathematical work to the extent of the B.Sc. degree.
Learning Objectives:	To enable students to • Use conceptual structures for modeling • Be able to perform appropriate conceptual scaling of given problems • Apply conceptual structures in practice, e.g. for requirements analysis, problems of logistics, decision support in management Use computer programs and algorithms for conceptual analysis (TOSCANAJ, ELBA, SIENA, CONEXP)
Course content:	Envelope systems and envelope operators. • Orders, associations, formal contexts, conceptual associations • Implications, knowledge acquisition through feature exploration. • Applications of conceptual associations in theory and practice • Multi-valued contexts, conceptual scaling, stepped line charts, application in data analysis. • Algorithms and computer programs for conceptual knowledge processing • Temporal conceptual analysis, states, transitions, lifelines, distributed objects.
Literature:	B. Ganter, R. Wille: Formal conceptual analysis - mathematical foundations. Springer-Verlag 1996. (In the textbook collection 20 copies available). • G. Stumme, R. Wille (eds.): Conceptual Knowledge Processing - Methods and Applications. Springer-Verlag 2000b • G. Stumme et al.: Computing iceberg concept lattices with TITANIC. Data & Knowledge Engineering 42(2):189-222, 2002. • R. Jäschke, A. Hotho, C. Schmitz, B. Ganter and G. Stumme: Discovering Shared Conceptualizations in Folksonomies. Web Semantics: Science, Services and Agents on the World Wide Web 6(1):38-53, 2008. • Current in-depth literature will be used to supplement this.
Forms of work / resources:	Lecture in seminar style, integrated exercise units, script, Exercises
Department:	Computer Science
Professional group:	Information Systems
Module responsibility:	Urs Andelfinger
Subject Competencies:	Formal, algorithmic, mathematical competencies: high • Analysis, design and implementation skills: medium • Technological competencies: medium
Supra-disciplinary competencies:	Project-related competencies: weak • Interdisciplinary competencies: Basic philosophical and epistemological competencies • Social and personal competencies: Analytical competence, judgment competence,

Foundations of Semantic Knowledge Graphs

Module number:	41.5054
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Catalog AS: Application and system-oriented modules Master 2013 - Catalog AS: Application and system-oriented modules MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+Pro = Lecture+Project
Weekly hours:	2+2
Credit Points:	6
Exam:	Individual semester project with final presentation (weight: 70%). Written assessment (weight: 30%)
Required knowledge:	Basic knowledge in web technologies and logics is expected. Basic application development skills are required.
Learning objectives:	After completing the course, students are able to... • understand concepts, technologies and languages used to create semantic knowledge graphs • apply the learned concepts in order to build a semantic knowledge graph for an individual business domain or application • utilize existing knowledge graphs for individual business applications • differentiate semantic knowledge graphs from other graph-based data structures • build ontologies and define the formal, model-theoretic semantics to be used in a knowledge graph • use state of the art ontology creation and management tools • query semantic knowledge graphs using standard semantic query languages (e.g. SPARQL)
Content:	The module consists of 7 main parts: 1. Introduction to knowledge graph terminology 2. Knowledge representation frameworks 3. Methods for ontology and knowledge graph construction 4. Query languages for semantic knowledge graphs (SPARQL) 5. Application and use cases of semantic knowledge graphs (information integration, query answering, navigation support etc.) 6. Individual project work 7. Final presentation and written assessment The following topics will be addressed • Fundamentals of semantic knowledge graph • Knowledge organization systems • Semantic knowledge representation frameworks • Ontology languages • Methods for ontology and knowledge graph creation • Query languages for semantic knowledge graphs • Utilization of knowledge graphs in real-world applications
Literature:	Hitzler, P., Krötzsch, M.,, Rudolph, S. (2010). Foundations of semantic web technologies. Chapman and Hall/CRC Press. ISBN: 9781420090505 • Markus Krötzsch, Frantisek Simancik, Ian Horrocks (2013). A Description Logic

	Primer. https://arxiv.org/abs/1201.4089 • M. Krötzsch, F. Simancik and I. Horrocks, "Description Logics," in IEEE Intelligent Systems, vol. 29, no. 1, pp. 12-19, Jan.-Feb. 2014. doi: 10.1109/MIS.2013.123 • Allison-Cassin, S. & Scott, D. (2018). Wikidata: a platform for your library's linked open data. Code4Lib, 40. • Vrandečić, D. & Krötzsch, M. (2014). Wikidata: A Free Collaborative Knowledgebase. Commun. ACM, 57, 78–85. doi: 10.1145/2629489 • https://www.wikidata.org/wiki/Wikidata:Main_Page Additional literature will be announced in the lectures.
Lecture style / Teaching aids:	Seminar-like teaching style with practical exercises and a semester project. Auxiliary tools will be announced in the lecture.
Faculty:	Computer Science
Expert group:	Artificial intelligence
Responsibility:	Stefan Zander
Professional competencies:	formal, algorithmic, mathematical competencies: medium • analytical, design and implementation competencies: high • technological competencies: high (Competency Areas: – Knowledge Graph Creation – Query Languages (SPARQL) – Ontology Creation – Ontology Languages (RDF, RDFS, OWL 2) – Knowledge Graph Utilization – Application Development) • capability for scientific work: medium
Interdisciplinary competencies:	• project related competencies: medium • interdisciplinary expertise: basic technical and natural scientific competence • social and self-competencies: leadership competence, analytical competence, competence of knowledge acquisition

Leadership skills and self-management

English title:	Leadership skills and self-management
Document numbers:	41.4912 [PVL 41.4913; Module 41.49120]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog SSK: Social and Personal Skills Master 2021 - Catalog SSK: Social and Personal Skills. Dual Master 2013 - Catalog SSK: Social and Self Competences Master 2013 - Catalog SSK: Social and Self Competences Master 2006 - Catalog S: Interdisciplinary Key Qualifications
Teaching Form:	S = Seminar
SWS:	4
CP:	5
Examination:	Technical discussion or oral examination
PVL (e.g. internship):	graded (regular participation, graded elaboration and graded impulse or technical presentation).
PVL share:	50%
Learning Objectives:	In this seminar, students acquire competencies that go beyond the

The students will learn that leadership is not just a matter of professional performance, but also requires the ability to deal confidently with oneself and others in order to be able to work in a team and interact effectively in an increasingly project-oriented working environment. With a view to the concrete work environment, students are familiarized with the central building blocks of successful operational leadership work and learn about the importance of corporate and organizational cultures for the leadership process. They learn to critically and constructively reflect on methods and techniques of successful leadership in the face of changing conditions in the company and, above all, acquire the ability to assess, adapt and optimize their own leadership and communication style. Students acquire self-management competencies and principle-oriented action in this seminar.

After completing the seminar, participants will be familiar with the central building blocks of successful operational leadership, will be able to realistically assess the importance of corporate and organizational cultures for the leadership process, and will be able to align their leadership actions accordingly.
Upon completion of the course, participants will be able to successfully formulate goals, as well as personal time and success planning. Participants will acquire methodological and key competencies for their self-management.

All participants will be able to apply the following methods and principles: Eisenhower principle and value analysis of time use.
(ABC analysis), 60:40 rule, ALPEN and Covey method for daily and weekly plans.

Course content:

Leadership skills:

- Management functions and tools
- Principles of effective leadership
- Tasks of effective leadership
- Tools of effective leadership
- Leadership styles in practice
- Communication as the basis for improving the management climate
- Dealing with difficult employees
- Promotion and motivation of employees
- Feedback and critical discussions
- Delegating tasks

Self-management:

- Methods of self and time management
- Successful goal formulation
- Personal time and success planning
- Principled action - The clock and the compass
- The main thing remains the main thing
- The 7 Ways to Effectiveness
- From time management to personal leadership
- Burn-out: causes and prevention
- Mindfulness and resilience

Literature:

Leading, Performing, Living - Effective Management for a New Era, Fredmund Malik, Heyne Business Verlag.

- The Way to the Essentials - Fourth Generation Time Management, Stephen R. Covey, A. Roger Merill, Rebecca R. Merill, Campus Publishers.
- The 7 Ways to Effectiveness - Principles for Personal and Professional Success, Stephen R. Covey, GABAL Verlag
- Leadership. Theory and Practice: Peter Northouse, SAGE Publications, 4th edition, 2007.

- The 7 Habits of highly effective people, Stephen R. Covey, Simon & Schuster UK Ltd.
- The Guru Guide - The Best Ideas of the Top Management Thinkers, Joseph Boyett & Jimmie Boyett, John Wiley & Sons, Inc.
- The 1 x 1 of time management, Lothar J. Seiwert, GABALVerlag
- More time for the essentials, Lothar J. Seiwert, GABALVerlag
- Talking to Each Other: Communication Psychology for Managers: Edited by Friedemann Schulz von Thun
- Talking to each other (1 - 3): Friedemann Schulz von Thun.
- Guide to Unhappiness: Paul Watzlawick
- International Management: Richard Mead, Blackwell Publishers
- Fundamentals of Management: Robbins, DeCenzo, Prentice Hall, 6th edition, 2008.
- Leadership in Organizations: Gary Yukl, Pearson, 7th edition.
- The Leadership Challenge: Kouzes & Posner, Wiley Publishers, 4th edition
- Harvard Business Manager Magazine
- Leadership Quarterly magazine

Forms of work / resources: Forms of workSeminar with many practical exercises, case studies, workshops, role plays and simulation games.
Resources: literature, scientific texts, scripts, worksheets and exercise sheets, impulse speeches, lectures and presentations, creativity techniques, blackboard, flipchart, overhead projector and/or beamer (depending on availability)

Department: Computer Science

Division: Social and Cultural Aspects of Computer Science

Module responsibility: Michael Massoth

Supra-disciplinary competencies: Project-related competencies: medium

- Interdisciplinary competencies: Psychological types basic competence, competencies of scientific work from an interdisciplinary point of view.
- Social and personal competencies: Leadership competence, teamwork competence, analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence, language competence, psychology competence (psychological types and potential analysis employees).

Functional Safety for Safety-Critical Software

Module numbers: 41.5074 [PVL 41.5075]

Language: english

Study programme: Dual Master 2021 - Catalog AS: Application and System Oriented Modules
Dual Master 2021 - Specialization SE: Software Engineering
Master 2021 - Catalog AS: Application and System-Oriented Modules
Master 2021 - Specialization SE: Software Engineering
Dual Master 2013 - Catalog AS: Application and System-Oriented Modules
Dual Master 2013 - Specialization SE: Software Engineering
Master 2013 - Catalog AS: Application and System Oriented Modules
Master 2013 - Specialization SE: Software Engineering
MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.

Type of course: V+P = Lecture+Practical

Weekly hours: 3+1

Credit Points:	6
Exam:	oral exam
PVL (e.g. Practical):	not graded
Required knowledge:	Sound knowledge in software engineering, Good programming skills
Learningobjectives:	The students can • recognize the difference between Usage Safety, Electrical Safety, and Functional Safety • write SW requirements • apply a Safety Analysis and Dependent Failure Analysis to software • recognize traceability between requirements, SW architectural design components, SW units, and source code • recognize criteria for choosing between source code reviews and SW unit testing
Content:	Based on a simple case study, it is shown that safety-critical software is based on two pillars: 1. Software engineering methodology, i.e. avoidance of "systematic faults": • Criteria state-of-the-art requirements specifications • Precise understanding of SW design modeling techniques (UML,SysML) • Fault indentification techniques (e.g. SW FMEA, Dependent Failure Analysis, Fault Tree Analysis (FTA)) • Difference between "SW Unit" and "SW component • Interplay between SW code metrics, SW unit testing, code reviews, SW integration testing • Traceability between requirements, SW design, code, test cases 2. Implemented fault detection & mitigation in code, e.g. • homogeneous and heterogeneous redundancy • HW-supported memory space protection vs. CRC checksums vs. double inverse storage • Task execution timing vs. high interrupt loads vs. controfl flow monitoring
Literature:	Functional safety in automobiles, ISO 26262, Systems engineering based on a safety life cycle, Carl Hanser, ASIN: B01LP371ZC. • Functional safety according to ISO 26262: A practical guide for implementation
Lecture style / Teaching aids:	Seminaristic lecture using parts of the ISO standard ISO 26262 and a mini case study
Faculty:	Computer Science
Expert group:	Software engineering
Responsibility:	Ralf Hahn
Professional competencies:	formal, algorithmic, mathematical competencies: low • analytical, design and implementation competencies: high • technological competencies: high • capability for scientific work: low
Interdisciplinary competencies:	• project related competencies: high

Genesis, design and use of technology

English Title:	Genesis, Shaping and Utilization of Technics.
Document number:	41.4920
Language:	GERMAN
Assignment:	Master 2021 - Catalog SWK: Social Science Competencies Master 2013 - Catalog SWK: Social Science Competencies Master 2006 - Catalog S: Interdisciplinary Key Qualifications.
Teaching Form:	S = Seminar
SWS:	2
CP:	2.5
Examination:	Presentation with short paper or thesis paper; possibly final test/exam (will be announced in the first course).
PVL (e.g., internship):	Continuous attendance, willingness to discuss
Learning Objectives:	Students will • become familiar with sociological and philosophical models of the social, economic, ecological, cultural and ethical conditions, effects and consequences of technology and science in society, • gain a deeper understanding of technology and science as part of the late modern knowledge and information society, • Practice methods for analyzing and evaluating case studies.
Course content:	Technology design between control and constraints. • Technology design actors • Models of technology development/genesis • Technology ethics and technology assessment • Case studies include: Telephone, Diesel/Wankel, Computer, Transrapid, Airbus, Atomic Bomb/Nuclear Technology, Coolant/CFC, Nanotechnology, Regenerative Energy Technology, Human Stem Cells/Biomedical Technology, Robotics.
Literature:	Weyer, J., 2008: Sociology of Technology. Genesis, design and control of socio-technical systems; Weinheim. • Weyer, J., Kirchner, U., Riedl, L., Schmidt, J.F.K., 1997: Technik die Gesellschaft schafft. Social Networks as a Site of Technology Genesis; Sigma, Berlin. • Degele, N., 2002: Einführung in die Techniksoziologie; Fink, Munich. • Mensch, K., Schmidt, J.C. (eds.), 2003: Technology and Democracy. Between Expertocracy, Parliament and Citizen Participation; Leske + Budrich, Opladen. • Grunwald, A., 2010: Technology Assessment - An Introduction, 2nd ed; Sigma, Berlin.
Forms of work / resources:	Seminarwith integrated lecture components
Department:	Computer Science
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Jan Schmidt
Supra-disciplinary competencies:	Project-related competencies: weak • Interdisciplinary competencies: Social science, ethical and philosophical basic competencies, basic competencies in the theory of science, competencies in scientific work in a field outside the subject area. • Social and personal skills: Ability to work in a team, analytical skills,

Judgment competence, decision-making competence, competence to acquire knowledge, presentation, documentation, teaching and consulting competence.

History of science and technology

English Title:	History of Science and Technology
Document number:	41.4954
Language:	GERMAN
Assignment:	Master 2021 - Catalog SWK: Social Science Competencies Master 2013 - Catalog SWK: Social Science Competencies Master 2006 - Catalog S: Interdisciplinary Key Qualifications.
Teaching Form:	S = Seminar
SWS:	2
CP:	2.5
Examination:	Presentation with short paper or thesis paper; possibly final test/exam (will be announced in the first course).
PVL (e.g., internship):	Continuous attendance, willingness to discuss
Learning Objectives:	Students will • Gain knowledge of the history of the natural and technical sciences in terms of content and methodology as well as in cultural and social terms since the 16th century; • be able to name the central natural and technical scientists, to describe their fundamental contributions to the further development of science, and to typify these contributions with regard to the philosophical background motifs; • Gain a deeper understanding of the scientific, social, cultural, and political environments in which the natural and technical sciences have been able to develop; • Knowledge of the approaches and methods of The concept of the history of science, in particular Kuhn's (phase) model of scientific revolutions and the concept of paradigms; • methodological skills in analysis, reflection, and the Acquire evaluation of the content contributions as well as the respective actions of the central natural and technical scientists.
Course content:	Introduction to the historiography of science (including Th. Kuhn's model of scientific revolutions); the beginning of modern science (Copernicus, Kepler); methodological foundation (experimentalism: Galileo; rationalism and mechanism: Descartes; institutionalization and organization: Bacon); Classical Mechanics (Newton); first The wave of mechanization and the steam engine (Newcomen, Watt, etc.); 19th century foundations (thermodynamics: Helmhotz, Boltzmann; electrodynamics: Faraday, Maxwell); temporality and evolution (evolutionary theory: Darwin, etc.); revolutions at the beginning of the 20th century. Century (theories of relativity: Einstein; quantum theories: Bohr, Heisenberg); the atom and its technology (bomb/Manhattan Project: Oppenheimer; nuclear power); the birth of computer science (Pascal, Leibniz, Zuse, Turing, Wiener, von Neumann); more recent developments (chaos theory/synergetics/dissipative structures, nano research, systems and synthetic biology; bioinformatics); technology assessment and dealing with the future.

Literature:	Kuhn, T.S., 1986: The structure of scientific revolution; Frankfurt. • Meyenn, K.v. (ed.), 1990: Triumph und Krise der Mechanik; Piper, Munich. • Locqueneux, R., 1989: Kurze Geschichte der Physik; Vandenhoeck, Göttingen. • Varchmin, J., Radkau, J., 1988: Kraft, Energie und Arbeit. Energie und Gesellschaft; Rowohlt, Reinbek. • Pörtner, R. (ed.), 1989: Sternstunden der Technik. Researchers and inventors change the world; Bastei Lübbe, Bergisch Gladbach. • Schmidt, J.C., 2008: Instability in nature and science; Berlin. • Kaku, M., 1998: Future Visions. How 21st century science and technology are revolutionizing our lives; Munich.
Forms of work / resources:	Seminarwith integrated lecture parts
Department:	Computer Science
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Jan Schmidt
Supra-disciplinary competencies:	Project-related competencies: weak • Interdisciplinary subject competencies: Historical and philosophical basic competence, basic competence in the theory of science, competences of scientific work in a field outside the subject. • Social and personal competencies: Ability to work in a team, analytical competence, decision-making competence, competence to acquire knowledge, presentation, documentation, teaching and consulting competence, competence to form judgments.

Hacker Contest

Document number:	41.5034
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	S+P = Seminar+Internship
SWS:	1+1
CP:	6
Exam:	Take over server, paper task, bonus task (with tasks from master task catalog).
Required Prior Knowledge:	This module benefits from technical knowledge in the following areas: • Linux operating system • Common vulnerabilities in software (e.g. OWASP Top 10) • Basic understanding of common communication protocols • The module can also be attended with only partial prior knowledge, provided that the student is willing to invest a lot of time.
Learning Objectives:	Students will • can identify vulnerabilities of IT systems (e.g. in web applications or other server components) and use them to penetrate the system

	• Are able to address weaknesses based on offensive experience • Develop an understanding of practical security problems and can use the understanding offensively as well as to secure IT systems • can apply and further develop security tools • Can implement offensive and defensive measures as a team
Course content:	Design and practical implementation of current attack methods. • Use of common hacking tools in a secured environment • Discussion of different IT security topics in the seminar
Literature:	P. Engebretson; The Basics of Hacking and Penetration Testing; Syngress; 2013. • P. Engebretson; Hacking Handbuch: Penetrationstests planen und durchführen; Franzis Verlag; 2015 • M. Ruef; The Art of Penetration Testing - Handbook for Professional Hackers; C & L; 2007 • J. Erickson; Hacking: The Art of the Exploit (2008). • BSI Penetration Test Guide (https://www.bsi.bund.de/DE/Publikationen/Studien/Pentest/index_htm.html) • OWASP Testing Guide (https://www.owasp.org/index.php/OWASP_Testing_Project) • Metasploit Unleashed (https://www.offensive-security.com/metasploit-unleashed/)
Forms of Work / Resources:	Seminaristic practical course
Department:	Computer Science
Expert group:	IT Security
Module responsibility:	Alex Wiesmaier
Professional competencies:	Formal, algorithmic, mathematical competencies: weak. • Analysis, design and implementation skills: high • Technological competencies: high • Ability to work scientifically: medium
Supra-disciplinary competencies:	Project-related competencies: high • Cross-curricular competencies: Basic technical and scientific competence, basic economic competence, basic legal competence. • Social and personal competencies: Ability to work in a team, analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence.

High Performance Computing

Module numbers:	41.5078 [PVL 41.5079; Module 41.50780]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system oriented modules Master 2021 - Catalog AS: Application and system oriented modules Dual Master 2013 - Catalog AS: Application and system-oriented modules Master 2013 - Catalog AS: Application and system-oriented modules MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Type of course:	V+P = Lecture+Practical

Weekly hours:	2+2
Credit Points:	6
Exam:	written exam
PVL (e.g. Practical):	graded
PVL percentage:	33%
Required knowledge:	Programming experience (e.g. C, C++, Python, Go, Rust, etc.).
Learningobjectives:	Studentsare able to first plan, then build and then analyze the performance of High Performance Computing (HPC) systems. More precisely, they are able to: • analyze problems and algorithms to discover inherent parallelism, • find the appropriate granularity for a given problem, i.e. choose between fine-grained and coarser-grained implementations, • use shared memory (multithreaded), message passing and hybrid approaches, • use, and choose between, currently available tools (programming languages, libraries, etc.), • apply best practice design patterns and methods, • measure and analyze the performance and scalability of HPC implementations.
Content:	Performance - Where it is needed, why it is needed, how to measure and analyze it. • Models of parallel computation • theoretical models such as PRAM and Dataflow Graphs • architectural models e.g. SIMD, MIMD, SPMD • Methods and patterns for parallel system design • The shared memory paradigm, both explicitly with multi-threaded programming and with compiler assistance via OpenMP. • The message passing paradigm with MPI and/or modern MOM approaches (e.g. ZeroMQ). • Heterogeneous hardware approaches, particularly with GPUs (Graphics Processing Units), using various techniques, e.g. OpenCL or OpenACC.
Literature:	Main Text • T. G. Mattson, B. A. Sanders & B. L. Massingill, Patterns for Parallel Programming, Addison-Wesley (Pearson Education), 2005. So helpful: • Clay Breshears, The Art of Concurrency, O Reilly Media Inc, 2009. • Ian Foster, Designing and Building Parallel Programs, Addison-Wesley Publishing, 1995. Cf. http://www.mcs.anl.gov/~itf/dbpp/. • Brendan Gregg, Systems Performance: Enterprise and the Cloud, 2nd Edition, Pearson, 2020.
Faculty:	Computer Science
Expert group:	Operating systems / distributed systems
Responsibility:	Ronald Moore
Professional competencies:	formal, algorithmic, mathematical competencies: medium • analytical, design and implementation competencies: high • technological competencies: high • capability for scientific work: medium
Interdisciplinary competencies:	• project related competencies: low • interdisciplinary expertise: basic technical and natural scientific competence • social and self-competencies: ability to work in a team, analytical competence, deciding competence, competence of knowledge acquisition, presentational, documentary, teaching and mentoring competence, fluency

Independent R&D Studies

Module number:	41.4972
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Dual Master 2013 - Specialization SE: Software Engineering Dual Master 2013 - Specialization TG: Technical and Graphical Systems Dual Master 2013 - Specialization WI: Business Informatics JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security Master 2013 - Specialization SE: Software Engineering Master 2013 - Specialization TG: Technical and Graphical Systems Master 2013 - Specialization WI: Business Informatics JIM 2006 - Courses Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization TC: Telecommunications Master 2006 - Specialization TS: Technical Systems Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	S = Seminar
Credit Points:	6
Exam:	Written elaboration
PVL (e.g. Practical):	Ungradedpreliminary examination work (e.g. documentation of the project work, seminar presentation, or written elaborations) will be announced at the beginning of the course. Regular and successful participation in R&D meetings with the supervising professor
Prerequisite for booking:	Written confirmation from the supervising professor of the FB I
Learningobjectives:	Theaim of the module is the independent familiarisation with a current field of research as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the Master's thesis. The contents must be discussed in advance with the supervising lecturer. Master students acquire in-depth and special R&D skills: • Ability to carry out independent scientific work, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a specific complex of computer science topics, as well as carrying out a source-critical evaluation and evaluation of the specialist literature. • Ability to research, develop and implement concepts such as independently evaluating, implementing and testing algorithms, solutions, technologies and procedures; e.g. independently designing, implementing, integrating, testing, evaluating and assuring quality. • Ability to write, publish and present scientific papers, e.g. to work independently write a scientifically sound written paper on a specific topic in computer science, to write a research proposal, to create system documentation. • Ability to identify differences between one's own and external results (plagiarism detection and plagiarism avoidance).

Further competences that can be acquired by the Master's student, for example, within the framework of this course:

- Methodical competences, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a certain subject area of computer science, as well as evaluating and assessing the specialist literature in a source-critical manner.
- Evaluate evaluation skills such as algorithms, solutions, technologies, and procedures independently,
- Project management competencies, such as planning R&D projects (incl. milestone plan, project structure plan, budget planning) and conducting feasibility studies,
- Innovation management skills on how to use and implement creative techniques and how to protect innovation through intellectual property rights.
- Perform solution competencies such as independent conception, system design, implementation, integration, testing, evaluation and quality assurance.
- Writing and scientific competence, e.g. independently writing a scientifically sound elaboration on a certain topic complex of computer science, writing a research proposal, creating system documentation.
- Communication skills, e.g. didactically designing and presenting a lecture on a certain topic complex of computer science using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively and profoundly contributing to the discussion on certain topics complexes of computer science; giving lectures at conferences.
- Social and personal skills, such as leadership, teamwork, analysis, judgment, decision-making, knowledge acquisition, presentation, documentation, teaching and advisory skills.

Content: The topic of the in-depth R&D studies is oriented towards the lecturer's current research and development projects and must be agreed individually with the student. The lecturer offers an in-depth R&D study according to the following three alternatives:

- Individual Study (with independent R&D study work)
- Individual Production (collaboration and practical implementation in R&D project with project completion report)
- Supervised Research (with peer-reviewed R&D paper)

Literature: Will be announced at the beginning of the course

Lecture style / Teaching aids: self-study,problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications

Faculty: Computer Science

Responsibility: Michael Massoth

Independent R&D Studies BI

Module number: 41.5066

Language: english

Study programme: Dual Master 2021 - Catalog AS: Application and system-oriented modules
Dual Master 2021 - Specialization WI: Business Informatics
Master 2021 - Catalog AS: Application and System-Oriented Modules
Master 2021 - Specialization WI: Business Informatics
Dual Master 2013 - Catalog AS: Application and system-oriented modules
Dual Master 2013 - Specialization WI: Business Informatics
Master 2013 - Catalog AS: Application and System-oriented Modules Master 2013 - Specialization WI: Business Informatics

Type of course:	S = Seminar
Credit Points:	6
Exam:	Written elaboration
PVL (e.g. Practical):	Ungradedpreliminary examination work (e.g. documentation of the project work, seminar presentation, or written elaborations) will be announced at the beginning of the course. Regular and successful participation in R&D meetings with the supervising professor
Prerequisite for booking:	Written confirmation from the supervising professor of the FB I
Learningobjectives:	Theaim of the module is the independent familiarisation with a current field of research as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the Master's thesis. The contents must be discussed in advance with the supervising lecturer. Master students acquire in-depth and special R&D skills: • Ability to carry out independent scientific work, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a specific complex of computer science topics, as well as carrying out a source-critical evaluation and evaluation of the specialist literature. • Ability to research, develop and implement concepts such as independently evaluating, implementing and testing algorithms, solutions, technologies and procedures; e.g. independently designing, implementing, integrating, testing, evaluating and assuring quality. • Ability to write, publish and present scientific papers, e.g. to work independently write a scientifically sound written paper on a specific topic in computer science, to write a research proposal, to create system documentation. • Ability to identify differences between one's own and external results (plagiarism detection and plagiarism avoidance). Further competences that can be acquired by the Master's student, for example, within the framework of this course: • Methodical competences, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a certain subject area of computer science, as well as evaluating and assessing the specialist literature in a source-critical manner. • Evaluate evaluation skills such as algorithms, solutions, technologies, and procedures independently, • Project management competencies, such as planning R&D projects (incl. milestone plan, project structure plan, budget planning) and conducting feasibility studies, • Innovation management skills on how to use and implement creative techniques and how to protect innovation through intellectual property rights. • Perform solution competencies such as independent conception, system design, implementation, integration, testing, evaluation and quality assurance. • Writing and scientific competence, e.g. independently writing a scientifically sound elaboration on a certain topic complex of computer science, writing a research proposal, creating system documentation. • Communication skills, e.g. didactically designing and presenting a lecture on a certain topic complex of computer science using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively and profoundly contributing to the discussion on certain topics complexes of computer science; giving lectures at conferences. • Social and personal skills, such as leadership, teamwork, analysis,

	judgment, decision-making, knowledge acquisition, presentation, documentation, teaching and advisory skills.
Content:	The topic of the in-depth R&D studies is oriented towards the lecturer's current research and development projects and must be agreed individually with the student. The lecturer offers an in-depth R&D study in the area of Business Informatics according to the following three alternatives: • Individual Study (with independent R&D study work) • Individual Production (collaboration and practical implementation in R&D project with project completion report) • Supervised Research (with peer-reviewed R&D paper)
Literature:	Will be announced at the beginning of the course
Lecture style / Teaching aids:	self-study,problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications
Faculty:	Computer Science
Responsibility:	Michael Massoth

Independent R&D Studies IS

Module number:	41.5068
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security
Type of course:	S = Seminar
Credit Points:	6
Exam:	Written elaboration
PVL (e.g. Practical):	Ungradedpreliminary examination work (e.g. documentation of the project work, seminar presentation, or written elaborations) will be announced at the beginning of the course. Regular and successful participation in R&D meetings with the supervising professor
Prerequisite for booking:	Written confirmation from the supervising professor of the FB I
Learningobjectives:	Theaim of the module is the independent familiarisation with a current field of research as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the Master's thesis. The contents must be discussed in advance with the supervising lecturer. Master students acquire in-depth and special R&D skills: • Ability to carry out independent scientific work, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a specific complex of computer science topics, as well as carrying out a source-critical evaluation and evaluation of the specialist literature. • Ability to research, develop and implement concepts such as independently evaluating, implementing and testing algorithms, solutions, technologies and

procedures; e.g. independently designing, implementing, integrating, testing, evaluating and assuring quality.
- Ability to write, publish and present scientific papers, e.g. to work independently write a scientifically sound written paper on a specific topic in computer science, to write a research proposal, to create system documentation.
- Ability to identify differences between one's own and external results (plagiarism detection and plagiarism avoidance).

Further competences that can be acquired by the Master's student, for example, within the framework of this course:

- Methodical competences, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a certain subject area of computer science, as well as evaluating and assessing the specialist literature in a source-critical manner.
- Evaluate evaluation skills such as algorithms, solutions, technologies, and procedures independently,
- Project management competencies, such as planning R&D projects (incl. milestone plan, project structure plan, budget planning) and conducting feasibility studies,
- Innovation management skills on how to use and implement creative techniques and how to protect innovation through intellectual property rights.
- Perform solution competencies such as independent conception, system design, implementation, integration, testing, evaluation and quality assurance.
- Writing and scientific competence, e.g. independently writing a scientifically sound written elaboration on a certain topic complex of computer science, writing a research proposal, creating system documentation.
- Communication skills, e.g. didactically designing and presenting a lecture on a certain topic complex of computer science using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively and profoundly contributing to the discussion on certain topics complexes of computer science; giving lectures at conferences.
- Social and personal skills, such as leadership, teamwork, analysis, judgment, decision-making, knowledge acquisition, presentation, documentation, teaching and advisory skills.

Content: The topic of the in-depth R&D studies is oriented towards the lecturer's current research and development projects and must be agreed individually with the student. The lecturer offers an in-depth R&D study in the area of IT-Security according to the following three alternatives:
- Individual Study (with independent R&D study work)
- Individual Production (collaboration and practical implementation in R&D project with project completion report)
- Supervised Research (with peer-reviewed R&D paper)

Literature: Will be announced at the beginning of the

course Lecture style / Teaching aids: Will be announced at the beginning of the

course Faculty: Computer Science

Responsibility: Michael Massoth

Independent R&D Studies SE

Module number: 41.5070

Language: english

Study programme: Dual Master 2021 - Catalog AS: Application and system-oriented modules

	Dual Master 2021 - Specialization SE: Software Engineering Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization SE: Software Engineering Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization SE: Software Engineering Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization SE: Software Engineering
Type of course:	S = Seminar
Credit Points:	6
Exam:	Written elaboration
PVL (e.g. Practical):	Ungradedpreliminary examination work (e.g. documentation of the project work, seminar presentation, or written elaborations) will be announced at the beginning of the course. Regular and successful participation in R&D meetings with the supervising professor
Prerequisite for booking:	Written confirmation from the supervising professor of the FB I
Learningobjectives:	Theaim of the module is the independent familiarisation with a current field of research as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the Master's thesis. The contents must be discussed in advance with the supervising lecturer. Master students acquire in-depth and special R&D skills: • Ability to carry out independent scientific work, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a specific complex of computer science topics, as well as carrying out a source-critical evaluation and evaluation of the specialist literature. • Ability to research, develop and implement concepts such as independently evaluating, implementing and testing algorithms, solutions, technologies and procedures; e.g. independently designing, implementing, integrating, testing, evaluating and assuring quality. • Ability to write, publish and present scientific papers, e.g. to work independently write a scientifically sound written paper on a specific topic in computer science, to write a research proposal, to create system documentation. • Ability to identify differences between one's own and external results (plagiarism detection and plagiarism avoidance). Further competences that can be acquired by the Master's student, for example, within the framework of this course: • Methodical competences, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a certain subject area of computer science, as well as evaluating and assessing the specialist literature in a source-critical manner. • Evaluate evaluation skills such as algorithms, solutions, technologies, and procedures independently, • Project management competencies, such as planning R&D projects (incl. milestone plan, project structure plan, budget planning) and conducting feasibility studies, • Innovation management skills on how to use and implement creative techniques and how to protect innovation through intellectual property rights. • Perform solution competencies such as independent conception, system design, implementation, integration, testing, evaluation and quality assurance. • Writing and scientific competence, e.g. independently writing a scientifically sound written elaboration on a certain topic complex of computer science,

writing a research proposal, creating system documentation.
- Communication skills, e.g. didactically designing and presenting a lecture on a certain topic complex of computer science using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively and profoundly contributing to the discussion on certain topics complexes of computer science; giving lectures at conferences.
- Social and personal skills, such as leadership, teamwork, analysis, judgment, decision-making, knowledge acquisition, presentation, documentation, teaching and advisory skills.

Content:	The topic of the in-depth R&D studies is oriented towards the lecturer's current research and development projects and must be agreed individually with the student. The lecturer offers an in-depth R&D study in the area of Software Engineering according to the following three alternatives: • Individual Study (with independent R&D study work) • Individual Production (collaboration and practical implementation in R&D project with project completion report) • Supervised Research (with peer-reviewed R&D paper)
Literature:	Will be announced at the beginning of the course
Lecture style / Teaching aids:	self-study,problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications
Faculty:	Computer Science
Responsibility:	Michael Massoth

Independent R&D Studies TG

Module number:	41.5072
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization TG: Technical and Graphic Systems Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Specialization TG: Technical and Graphic Systems Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphic Systems Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems
Type of course:	S = Seminar
Credit Points:	6
Exam:	Written elaboration
PVL (e.g. Practical):	Ungradedpreliminary examination work (e.g. documentation of the project work, seminar presentation, or written elaborations) will be announced at the beginning of the course. Regular and successful participation in R&D meetings with the supervising professor
Prerequisite for booking:	Written confirmation from the supervising professor of the FB I
Learningobjectives:	Theaim of the module is the independent familiarisation with a current field of research as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the Master's thesis. The contents must be discussed in advance with the supervising lecturer. Master students acquire in-depth and special R&D skills:

- Ability to carry out independent scientific work, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a specific complex of computer science topics, as well as carrying out a source-critical evaluation and evaluation of the specialist literature.
- Ability to research, develop and implement concepts such as independently evaluating, implementing and testing algorithms, solutions, technologies and procedures; e.g. independently designing, implementing, integrating, testing, evaluating and assuring quality.
- Ability to write, publish and present scientific papers, e.g. to work independently write a scientifically sound written paper on a specific topic in computer science, to write a research proposal, to create system documentation.
- Ability to identify differences between one's own and external results (plagiarism detection and plagiarism avoidance).

Further competences that can be acquired by the Master's student, for example, within the framework of this course:

- Methodical competences, e.g. independently researching, compiling and familiarising oneself with relevant specialist literature on a certain subject area of computer science, as well as evaluating and assessing the specialist literature in a source-critical manner.
- Evaluate evaluation skills such as algorithms, solutions, technologies, and procedures independently,
- Project management competencies, such as planning R&D projects (incl. milestone plan, project structure plan, budget planning) and conducting feasibility studies,
- Innovation management skills on how to use and implement creative techniques and how to protect innovation through intellectual property rights.
- Perform solution competencies such as independent conception, system design, implementation, integration, testing, evaluation and quality assurance.
- Writing and scientific competence, e.g. independently writing a scientifically sound written elaboration on a certain topic complex of computer science, writing a research proposal, creating system documentation.
- Communication skills, e.g. didactically designing and presenting a lecture on a certain topic complex of computer science using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively and profoundly contributing to the discussion on certain topics complexes of computer science; giving lectures at conferences.
- Social and personal skills, such as leadership, teamwork, analysis, judgment, decision-making, knowledge acquisition, presentation, documentation, teaching and advisory skills.

Content:

The topic of the in-depth R&D studies is oriented towards the lecturer's current research and development projects and must be agreed individually with the student. The lecturer offers an in-depth R&D study in the area of Technical and Graphical Systems according to the following three alternatives:

- Individual Study (with independent R&D study work)
- Individual Production (collaboration and practical implementation in R&D project with project completion report)
- Supervised Research (with peer-reviewed R&D paper)

Literature: Will be announced at the beginning of the course

Lecture style / Teaching aids: self-study,problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications

Faculty: Computer Science

Responsibility: Michael Massoth

Interactive decision theory (game theory)

English title:	Interactive decision theory (game theory)
Document numbers:	41.5038 [PVL 41.5039]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2021 - Specialization WI: Business Information Systems. Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization WI: Business Informatics Dual Master 2013 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Specialization WI: Business Informatics Master 2013 - Catalog AS: Application and System-oriented Modules Master 2013 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+Ü = Lecture+Exercise
SWS:	2+2
CP:	6
Exam:	Written exam
PVL (e.g. practical course):	ungraded (processing of exercise, development or design tasks)
RequiredPrevious knowledge:	None, basic knowledge of classical decision theory is an advantage.
Learning objectives:	This course deals with interactive decision-making situations in which two or more decision-makers acting rationally (or intentionally rationally) each pursue their own economic interests. Such situations occur in almost all practically significant conflict situations in business information systems, but also in e.g. in the economy or politics. Currently known examples are the auction of mobile phone frequencies, auction portals on the Internet or the emergence of networks of relationships in social networks. The students should be able to deal with such situations: • recognize, understand and critically discuss how the consequences of the decision of one party involved also depends on the decisions of the other party(ies), but each party pursues its own goals, which can lead to conflicts, • different interactive processes that occur in practice Be able to classify and formally describe decision scenarios, • Be able to solve example scenarios, • develop the ability to recognize and discuss the possibilities and limits of theory by means of numerous practical examples, • be able to critically discuss the problem of how to define "rational action" and identify adequate approaches to solving it
Course content:	Propaedeutics and basics • Extensive form, normal form and mixed extension • Equilibria • Non-cooperative scenarios: – Two-person zero-sum conflicts – Bimatrix scenarios • Cooperative scenarios: – Two decides – N > 2 Decision maker
Literature:	Bamberg G, Coenenberg A, Krapp M: Betriebswirtschaftliche Entscheidungslehre, 15th edition Vahlen, Munich (2012). • Holler M, Illing G: Introduction to game theory, 6th edition. Springer, Berlin et al. (2006).

- Von Neumann J: "On the theory of parlor games". Mathematische Annalen, 100, 295-320 (1928).
- von Neumann J, Morgenstern O: Theory of games and economic behavior. Princeton University Press, Princeton, New Jersey, USA (1944).

(Further literature will be announced during the course).

Department:	Computer Science
Professional group:	Information Systems
Module responsibility:	Oliver Skroch
Professional competencies:	Ability to work scientifically: weak.

IoT Technologies

English Title:	IoT Technologies
Document numbers:	41.5076 [PVL 41.5077; Module 41.50760]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphic Systems Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Teaching Form:	V+S+P = Lecture+Seminar+Internship.
SWS:	2+1+1
CP:	6
Examination:	Written exam (preparation of a technology study as a graded written paper with presentation of the results; compulsory attendance at all seminar sessions and internship dates)
PVL (e.g., internship):	Graded
PVL share:	50%
Required Prior Knowledge:	General undergraduate level knowledge of databases, file systems, technical principles of computer science and programming, basics of IP such as HTTP and OSI layer model are helpful.
Learning Objectives:	Classify and apply IoT technologies (hardware and software). • Identify and specify technology requirements for networked and resource-constrained systems in the Internet of Things (IoT). • Knowledge of design and implementation of exemplary IoT technologies for hardware, middleware, radio technologies • Knowledge of IoT data properties and processing • Modeling and criteria for the evaluation of non-functional properties • Transmission and storage of large amounts and volumes of IoT data • Evaluate the impact of low power lossy networks and data access patterns. • Classify and apply IT security features for IoT technologies. • Understanding of IoT architectures and their overall system characteristics • Acquire a data-centric and data-flow-oriented view and consider the underlying technical systems
Course content:	Architecture and technologies in IoT • Abstraction layers: Memory, Data, Information

- IoT hardware and wireless technology
- High volume and volume requirements of IoT data sets
- IoT cloud architecture and object storage for distributed storage
- Example technologies for sensor networks or IoT data networks such as IoT SOCs, CoAP, MQTT, OPC UA, Blockchain, IoT wireless technologies such as LPWA/LoRa, 6loWPAN, BLE.
- Network, protocol and time properties in the IoT
- CAP theorem in event-driven IoT architectures.
- Modeling approaches of non-functional properties in the IoT
- IoT data - properties, access patterns, processing and evaluation
- IoT architectures and overall system characteristics
- Identity Management and IT Security Features in IoT
- Further aspects of data management in storage networks and the IoT

Literature:

Ulf Troppens, Nils Haustein, "Speichernetze", 3rd edition, dpunkt, 2019.

- Dirk Slama, "Enterprise IoT", O'Reilly, 2015
- Gastón C. Hillar, "MQTT Essentials - A Lightweight IoT Protocol", Packt, 2017.
- Wolfgang Mahnke et.al., "OBC Unified Architecture", Springer, 2009
- Zach Shelby, Carsten Bormann, "6loWPAN - the wireless Embedded Internet", Wiley, 2009.
- Joe Arnold & members of the SwiftStack team, OpenStack Swift - using, administering, and developing for Swift Object Storage, O'Reilly Verlag, 2014.
- Shuang-Hua Yang, "Wireless Sensor Networks", Springer Verlag 2014.
- Parikshit N. Mahalie et.al, Identity for Internet of Things, River Publishers, 2015.

Forms of work / resources: Lecturewith seminar and practical course; the knowledge acquired in the lecture is deepened in the seminar by means of active group exercises of all participants and thus linked to the application in the practical course. In the practical course, the understanding of the approaches is practiced and deepened through investigations and the creation of individual technology studies.

Department: Computer Science

Expert group: Computer Engineering

Responsible for the module: Jens-Peter Akelbein

Professional competencies:

Formal, algorithmic, mathematical competencies: weak.

- Analysis, design and implementation skills: medium
- Technological competencies: high
- Ability to work scientifically: medium

Supra-disciplinary competencies: Project-related competencies: medium

- Interdisciplinary Subject Competencies: Basic technical and scientific competencies, from related disciplines such as electrical engineering and data science.
- Social and personal competencies: Language competence

IT-supported process management

English title: IT-based process management

FrenchTitle: Ingénieriedes processus et systèmes

d'information Document numbers: 41.4856 [NFE109; PVL 41.4857; Module 41.48560]

Language: GERMAN

Assignment: CNAM - Master cycle
CNAM Master - Master cycle
Dual Master 2021 - Catalog AS: Application and System-oriented Modules

	Dual Master 2021 - Specialization WI: Business Informatics Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization WI: Business Informatics Dual Master 2013 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Specialization WI: Business Informatics Master 2013 - Catalog AS: Application and System-oriented Modules Master 2013 - Specialization WI: Business Informatics Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization TC: Telecommunications Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	2+2
CP:	6
Exam:	Written exam
PVL (e.g. internship):	graded (graded elaboration (and presentation, if applicable); ungraded
internship) Proportion PVL:	30%.
RequiredPrevious knowledge:	Basic knowledge ofbusiness administration at least to the extent of the bachelor's compulsory lecture is required. Recommended supplementary course in the Master's program is e.g. "Business Process Engineering". Whereas this course focuses on the overall business context, the Business Process Engineering course then takes a more in-depth look at the content in the direction of concrete IT implementation.
Learning Objectives:	Students will • Know and understand basic concepts of process-oriented organizations, in particular dualism of organizational structure and process organization and the value chain as the guiding idea of every company. • Know and understand forms of application of IT in process-oriented organizations, e.g. for operational process control, for information purposes, for rationalization, but also with regard to disruptive effects, such as the synchronous availability of the same information in many places (and what this then enables in terms of new business processes). • IT process management as the link between corporate strategy and IT implementation: IT process management implements the strategy, but at the same time also inspires new strategic concepts and sets constraints. • Business processes using modeling languages (EPK, BPMN) analyze, model and evaluate statically-quantitatively (typical, minimum and maximum lead times and costs). • Know reference process models for process-oriented organizations and understand (e.g. industry standard software) • know alternative implementation options for IT process management and be able to evaluate them comparatively (reengineering vs. evolutionary improvement) • Know typical starting points for optimization in IT process management and be able to apply them in practical case studies (e.g., elimination of redundancies, parallelization, clarification of responsibilities, bundling, bottlenecks) • Develop an awareness of the change management and ethical aspects of IT process management. • Acquire basic knowledge of IT business alignment and know reference models such as Henderson & Venkatraman

Course content:	From a function-oriented to a (business) process-oriented view of companies. • IT-supported process management as a link between corporate strategy and operational implementation (Business Process Engineering) • Procedure models for business process management • Modeling methods of business processes, e.g. – Tables and diagrams and flowcharts – event-driven process chains (example: ARIS) – Executable modeling languages (example: BPMN) • Metamodeling and reference process models • Performance evaluation of business processes and simulation with the aim of process optimization • Legal and social aspects in the design and introduction of process management • Change management as a necessary complement to process management • Case studies on process management • In the practical course the focus is on the exemplary implementation of the theoretical parts by means of case studies and the exemplary acquaintance with commercial process modeling tools.
Literature:	H. J. Schmelzer, W. Sesselmann: Business Process Management in Practice. 7th ed. Munich Vienna: Carl Hanser Verlag, 2010 • Th. Allweyer: Business Process Management: Strategy, Design, Implementation, Controlling. W3L-Verlag, Herdecke 2005 • M. Osterloh, J. Frost: Prozessmanagement als Kernkompetenz, Wiesbaden: Gabler Verlag, 5th edition, 2006 • A. Gadatsch: Grundkurs Geschäftsprozessmanagement, Braunschweig/Wiesbaden: Verlag Vieweg, 7th edition, 2012 • J. Becker, M. Kugeler, M. Rosemann (Eds.): Prozessmanagement. 6th ed., Springer-Verlag, 2008. • M. Hammer, J. Champy: Business Reengineering, die Radikalkur für das Unternehmen, Frankfurt a. M. 1994 (original title: Reengineering the Corporation).
Forms of work / resources:	Seminar lecture, practical course, partly in the laboratory with Process modeling tools (e.g. ARIS) and SAP Process Modeler Digital slide sets and exercises, Current journal articles Case studies on business process engineering, Research papers
Department:	Computer Science
Professional group:	Information Systems
Module responsibility:	Urs Andelfinger
Professional competencies:	Formal, algorithmic, mathematical competencies: weak. • Analysis, design and implementation skills: medium • Technological competencies: weak (basic understanding of business application systems and ERP systems). • Ability to work scientifically: high
Cross-curricular competencies:	Cross-curricular subject competencies: Basic economic competence • Social and personal competencies: Analysis competence, judgment competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence.

IT Management

Document numbers:	41.5098 [PVL 41.5099]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and system-oriented modules Master 2013 - Catalog AS: Application and system-oriented modules MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	3+1
CP:	6
Exam:	Written exam (90 minutes)
PVL (e.g. internship):	ungraded(successful participation in ungraded internship)
RequiredPrior knowledge:	Fundamentals of Information Systems
Learning objectives:	Students will be able to recognize, use, and control IT as an essential and value-added business resource by • Know basic business management concepts and use them in analyzing use • Understand and apply key performance indicator systems to assess the functionality and cost-effectiveness of IT, • Understand business information aspects of quality of service agreements and contracts and be able to demonstrate compliance, • Know compliance as an essential requirement and take it into account in controlling. The students know the basics of IT governance and can discuss different concepts, advantages and disadvantages for companies from a strategic and economic point of view. The different instruments of IT governance are known and can be used independently and problem-related. Students know the basics of IT service management and can understand the link to project management beyond project completion and implemented on the basis of concrete examples. IT service management processes are known and the goals of the individual processes are understood. The End-to-end connection of the processes, which are composed individually, depending on different cases, can be implemented in different case studies. Students will be able to understand how service management can provide efficient customer/business support.
Course content:	Basics of IT management (definitions, delimitations, classifications, Organization) • Strategic IT management, portfolio considerations, total cost of ownership, cost/benefit analysis (NPV), IT controlling • Different concepts of IT governance and their influences on the operational day-to-day business • Introduction to IT quality management, standards and regulations (ISO, COBIT, GDPR, GxP) • Basics of IT Service Management - typical processes, Service Thought (ITIL) (Strategic and Operational Service Management processes, connection to IT- Project Management) • Portfolio management (connection between service portfolio and project

Portfolio)
- Risk Management
- IT Performance Management

Literature:
Gaulke, Markus (2020): Praxiswissen COBIT Grundlagen und praktische Anwendung in der Unternehmens-IT.
- Keller, Wolfgang (2017): IT Enterprise Architecture: From Business Strategy to Optimal IT Support.
- Resch, Olaf (2020): Introduction to IT Management: Fundamentals, Implementation, Best Practice (ESVbasics).
- Scholderer, Robert (2016): Management of Service Level Agreements: Methodological Foundations and Practical Solutions with COBIT, ISO 20000 and ITIL.
- Tiemeyer, Ernst. (Ed.) (2020): Handbuch IT Management - Konzepte, Methoden, Lösungen und Arbeitshilfen für die Praxis, Hanser, Munich.
- Urbach, Nils/Ahlemann, Frederik (2016): IT Management in the Age of Digitalization

Forms of work / resources: Seminar-style lecture with case studies and practical tasks Department:

Computer Science

Professional group: Information Systems

Module responsibility: Katja Lenz

Professional competencies:
Formal, algorithmic, mathematical competencies: weak.
- Analysis, design and implementation skills: medium
- Technological competencies: medium ((exemplary use of software for IT service management))
- Ability to work scientifically: medium Supra-

disciplinary competencies : Project-related competencies: medium

Language-Oriented Programming

Module number: 41.4960

Language: english

Study programme:
Dual Master 2021 - Catalog AS: Application and system-oriented modules
Master 2021 - Catalog AS: Application and system-oriented modules
Dual Master 2013 - Catalog AS: Application and System-Oriented Modules
Dual Master 2013 - Specialization SE: Software Engineering
JIM 2013 - Elective Catalogue J
Master 2013 - Catalog AS: Application and System Oriented Modules
Master 2013 - Specialization SE: Software Engineering
JIM 2006 - Courses
Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering
MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.

Type of course: VP = Lecture with integrated Practical

Weekly hours: 6

Credit Points: 9

Exam: oral exam

Required knowledge:
English language skills (understanding, speaking, reading, writing)
- Sound software design experience
- Proficiency in at least two programming languages, best in different language styles (e.g., object-oriented and functional)

Learningobjectives:	Thestudents shall achieve the following skills in advanced programming and design: • Be proficient in different programming language styles, e.g., objectoriented, functional, and logic • Be familiar with the concepts of domain-specific languages (DSLs) and meta-programming using extensible programming languages • Be proficient in particular DSLs, e.g., for queries, workflows, and for tests • Be proficient in designing new DSLs • Be proficient in implementing new DSLs • Be proficient in integrating components, implemented in different languages, within a complex application
Content:	The Lisp programming language, including Lisp macros. • Functional programming • Advanced object-oriented programming • Logic programming • Using pre-defined DSLs • Improving DSLs • Designing and implementing new DSLs using DSL stacking • Integrating components, implemented in different languages, within a complex application The skills will be practised in the laboratory by implementing a complex, realistic business information system using Common Lisp.
Literature:	Martin P.Ward. Language-Oriented Programming. Software - Concepts and Tools, 15(4):147{161, 1994. • Sergey Dmitriev. Language Oriented Programming: The Next Programming Paradigm: http://www.onboard.jetbrains.com/is1/articles/04/10/lop, 2005. • Jack Greeneld. Software Factories: Assembling Applications with Patterns, Models, Frameworks, and Tools: http://msdn.microsoft.com/en-us/library/ms954811.aspx, 2004. • W. F. Clocksin and Chris Mellish. Programming in Prolog, 3rd Edition. Springer, 1987. • Peter Seibel: Practical Common Lisp. Apress. 2005 • Guy L. Steele. COMMON LISP: The Language. Digital Press, 12 Crosby Drive, Bedford, MA 01730, USA, 1984.
Lecture style / Teaching aids:	Workshop-style lecture and laboratory interleaved • Team work with notebooks and shared code • Media: presentations, white board, Wiki, integrated development environment, books and current articles
Faculty:	Computer Science
Expert group:	Programming
Responsibility:	Bernhard Humm

Logic

English title:	Logic
Document numbers:	41.4970 [PVL 41.4971]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog T: Theory-oriented Modules Master 2021 - Catalog T: Theory-oriented Modules. Dual Master 2013 - Catalogue T: Theory-oriented Modules JIM 2013 - Elective Catalogue T Master 2013 - Catalog T: Theory-oriented modules

	Master 2006 - Catalog T: Theory-oriented modules MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+Ü = Lecture+Exercise
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. practical course):	ungraded (successful participation in the exercises: The preliminary examination performance has been achieved if 50% of the exercise problems have been worked on, correct solutions for two exercise problems have been presented during the exercise and a correct sample solution for one exercise problem has been worked out and handed in).
Learning Objectives:	The focus is on the following learning objectives: • Understanding the interplay between syntax and semantics of logics • Understanding of theories, their formal and their practical meaning • Ability to choose between alternative algorithms and methods for logical questions (satisfiability, refutability, generality, ...) select and apply them correctly • Ability to lead evidence or review evidence presented. • Ability to apply dedicated logics beyond classical logics to address specific application areas
Course content:	mathematical basics: sets, languages, induction, recursion. • Syntax and semantics of propositional logic • Algorithms and deduction systems for propositional problems • Syntax and semantics of predicate logic 1. level • Algorithms and deduction systems for predicate logic problems • important mathematical theorems about propositional and predicate logic • other logics (modal logic, temporal logic) Parallel to lecture and exercise, students work independently on the topic of multimodal logics and description logics (with comprehension check in a written exam).
Literature:	Schöning, U.: Logik für Informatiker. 5th ed. Spectrum. 2000. • Kreuzer, M., Kühling, S.: Logik für Informatiker. Pearson Studies. 2006. • Dassow, J.: Logik für Informatiker. Teubner.
2005.Work forms / resources:	Script,exercise sheets.
Department:	Computer Science
Expert group:	Theoretical Computer Science
Module responsibility:	Gunter Grieser
Subject Competencies:	Formal, algorithmic, mathematical competencies: high • Analysis, design and implementation skills: weak • Ability to work scientifically: medium
Cross-curricular competencies:	Cross-curricular competencies: Mathematical and basic scientific literacy

Moderation and conflict management

English Title:	Moderation and Conflict Management
Document number:	41.4914
Language:	GERMAN

Assignment:	Dual Master 2021 - Catalog SSK: Social and Personal Skills Master 2021 - Catalog SSK: Social and Personal Skills. Dual Master 2013 - Catalog SSK: Social and Self Competences Master 2013 - Catalog SSK: Social and Self Competences Master 2006 - Catalog S: Interdisciplinary Key Qualifications
Teaching Form:	S = Seminar
SWS:	2
CP:	2.5
Exam:	Exercises, lectures, regular participation in the seminar
Learning Objectives:	Students will • Learn general communication theories as well as the specifics of conflict situations. • Be able to analyze conflict and communication processes from different perspectives. • get to know different methods of conversation moderation as well as conflict management. • Learn to practice, deepen and apply moderation and communication strategies in the context of conflict situations through practical exercises.
Course content:	Theoretical foundations of communication, understanding and conflict, Classification of the concept of conflict, analysis of the causes of conflict, methods of conflict management, conflict management
Literature:	Seifert, J.W. (1995), Visualisieren, Präsentieren, Moderieren, Bremen. • Schulz von Thun (2011) Miteinander reden 1-3. Hamburg • Benin, K. (2003): Conducting difficult conversations. Hamburg. • Hugo-Becker, A./Becker, H. (1992), Psychological Conflict Management, Munich.
Forms of work / resources:	Seminar-style lecture with exercises, practical facilitation exercises, Role-playing games, scenarios
Department:	SuK Accompanying Studies
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Kai Schuster
Cross-curricular competencies:	Interdisciplinary subject competencies: Social theory Basic competence, basic competence in social sciences, competences of scientific work from an interdisciplinary point of view. • Social and personal skills: Leadership skills, teamwork skills, Analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence, language competence

Motion Planning

Module numbers:	41.5080 [PVL 41.5081]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization TG: Technical and Graphic Systems Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Specialization TG: Technical and Graphic Systems Dual Master 2013 - Catalog AS: Application and System Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphical Systems

	Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization TG: Technical and Graphical Systems MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+S+P = Lecture+Seminar+Practical
Weekly hours:	2+1+1
Credit Points:	6
Exam:	written exam
PVL (e.g. Practical):	not graded
Required knowledge:	none
Learning objectives:	Students should finish the course with the ability: • to evaluate different strategies to solve motion planning problems • to use computational tools to implement solutions for motion planning problems • to improve the ability to read and evaluate scientific literature • to practice in conveying research results to an audience
Content:	The foundations of motion planning and state-of-the-art algorithms are illustrated in the context of several important applications, including robotics, computational biology, and computer animation. The course covers both classic results and, selectively, advances from recent research. Students will complete several practical exercises and/or a project that involves substantial programming in order to gain working knowledge of the topics covered in the class.
Literature:	Steven M. Lavalle. Planning Algorithms. Cambridge University Press. 2006. Available online at http://planning.cs.uiuc.edu/ • H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki and S. Thrun, Principles of Robot Motion: Theory, Algorithms, and Implementations ISBN-13: 978-0-262-03327-5 • K.M. Lynch, F.C. Park: Modern Robotics - Mechanics, Planning, and Control Cambridge University Press, 2017.
Lecture style / Teaching aids:	Seminaristiclecture with seminar and laboratory. Resources include lecture notes, example programs and software tools.
Faculty:	Computer Science
Expert group:	Computer engineering
Responsibility:	Thomas Horsch
Professional competencies:	formal, algorithmic, mathematical competencies: medium • analytical, design and implementation competencies: high • technological competencies: medium • capability for scientific work: medium
Interdisciplinary competencies:	• interdisciplinary expertise: basic technical and natural scientific competence • social and self-competencies: competence of knowledge acquisition

Motion Planning

Document numbers:	41.4870 [PVL 41.4871]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization TG: Technical and Graphical Systems.

	Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization TG: Technical and Graphical Systems Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphic Systems Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems Master 2006 - Catalog AS: Application and system oriented modules MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching Form:	V+S+P = Lecture+Seminar+Internship.
SWS:	2+1+1
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded (Unbenottetes Praktikum).
Learning Objectives:	Students taking this course, • master procedures that enable efficient planning of movement in multidimensional spaces, • Are able to apply various strategies to solve and evaluate motion planning problems, • can use software tools to solve such problems, • further develop their ability to read and classify scientific literature in the field.
Course Content:	The basic methods for motion planning (motion planning) and current algorithms are presented in the context of important applications in robotics, computer animation and computational biology. The course covers classical methods as well as - selectively - recent research results. Students perform several practicals in the form of programming assignments and/or present selected topics in the form of smaller practical projects.
Literature:	Steven M. Lavalle. Planning Algorithms. Cambridge University Press. 2006. Available online http://planning.cs.uiuc.edu/ • H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki and S. Thrun, Principles of Robot Motion: Theory, Algorithms, and Implementations ISBN-13: 978-0-262-03327-5
Work forms / resources:	seminarlecture; script, tool for simulation Department:
	Computer Science
Expert group:	Computer Engineering
Module responsibility:	Thomas Horsch
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: high • Technological competencies: medium • Ability to work scientifically: medium
Cross-curricular competencies:	Cross-curricular competencies: Technical and basic scientific literacy • Social and personal competencies: Competence to acquire knowledge

Natural Language Processing

Module numbers:	41.5086 [PVL 41.5087; Module 41.50860]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system oriented modules Master 2021 - Catalog AS: Application and system oriented modules Dual Master 2013 - Catalog AS: Application and system-oriented modules Master 2013 - Catalog AS: Application and system-oriented modules MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Type of course:	V+P = Lecture+Practical
Weekly hours:	2+2
Credit Points:	6
Exam:	written exam
PVL (e.g. Practical):	graded(Group project from one of the subfields of NLP - incl. Documentation; graded individual assignments)
PVL percentage:	50%
Requiredknowledge:	Basicconcepts and ways of thinking in the field of artificial intelligence (Bachelor level)
Learning objectives:	The students will • understand the relevance of Natural Language Processing (NLP) as a sub-field of Artificial Intelligence • understand the complexity of NLP applications, and on the basis of a detailed analysis, point at the problem and become sensible w.r.t a solution • get familiar with NLP tools and apply them • acquire knowledge in the subfields of NLP: morphology, tokenization, tagging, electronic dictionaries, syntax, semantics, Machine Translation (rule-based and statistical), Text Mining, and Speech Recognition • understand the connection between NLP and Computational Linguistics, i.e. different views on the same field • become sensible to problems in the NLP field - focusing on disambiguation on different levels (word-, sentence-, text-, web) • have acquired theoretical skills across the entire field of NLP and will be able to apply them • be able to analyze an NLP problem, design & implement a prototypical solution and document the work
Content:	This course will cover the following aspects of Natural Language Processing (NLP): tokenization, tagging, parsing, morphology, electronic dictionaries, problems in homonyms and disambiguation in general, machine translation, syntax, grammatical theories, CD structures, RTNs, ATNs, electronic grammar checking, statistical language processing: Bayes Rules and Hidden Markov Models.
Literature:	Jurafsky, Daniel. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. Prentice Hall, 2008. • Manning/Schütze. Foundations of Statistical Language Processing. Foundations of Statistical Natural Language Processing. MIT Press. 1999. • Pierre Nugues. An Introduction to Language Processing with Perl and Prolog: An Outline of Theories, Implementation and Application with Special Consideration of English, French, and German (Cognitive Technologies). Springer Berlin Heidelberg, 2009.
Lecture style / Teaching aids:	Seminaristic Lecture; Videos of the Lectures; Slides

Faculty:	Computer Science
Expert group:	Artificial intelligence
Responsibility:	Bettina Harriehausen
Professional competencies:	formal, algorithmic, mathematical competencies: medium • analytical, design and implementation competencies: medium • technological competencies: medium • capability for scientific work: high
Interdisciplinary competencies:	• project related competencies: medium • interdisciplinary expertise: basic technical and natural scientific competence

Network Simulation

Module number:	41.5050
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Catalog AS: Application and system-oriented modules Master 2013 - Catalog AS: Application and system-oriented modules MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	VP = Lecture with integrated Practical
Weekly hours:	4
Credit Points:	6
Required knowledge:	Solid programming skills in C++ and Basics in Computer Networks
Learningobjectives:	NetworkSimulations are used to study the behavior of computer networks in software. In this practical course, students will program their own network simulations in C++. Supported by a state-of-the-art simulation engine, students • will learn how to model, study and benchmark essential parts of communication networks (e.g., wireless and wired links, Internet routers, cellular base stations, Web servers). • will be trained to differentiate meaningful results from randomness, to avoid common pitfalls in simulation design and result interpretation, as well as to plan for large simulations at scale.
Content:	Essential statistics: Random variables, probability distributions, Goodness of Fit tests. • Simulation concepts and background: Monte-Carlo, Discrete-Event, random number generation, the OMNeT++ simulation framework • Models and data structures for Network Simulation: Selecting distributions, arrival processes, network traffic models, queueing systems, heaps & Co. • Interpreting output data: estimating means, computing confidence intervals, comparing systems, handling correlation, (in)validating models • Planning simulations: Experimental design, 2k factorial designs, metamodels • Common pitfalls: Parallel random number generation, initial transient, multivariate processes, dependent factors
Literature:	A. Law, Simulation Modeling and Analysis, 5th edition, 2006. • Jack L. Burbank, William Kasch, Jon Ward, An Introduction to Network Modeling and Simulation for the Practicing Engineer, 2011. • A. Varga, "OMNeT++ User Guide", available at: https://omnetpp.org, 2016 • Further references will be provided during the lecture

Lecture style / Teaching aids:	Thecourse will take place in a computer lab: Computers, software, and source code examples will be provided. Students can use their own laptops as well.
Faculty:	Computer Science
Expert group:	Telecommunications
Responsibility:	Stefan Valentin
Professional competencies:	formal, algorithmic, mathematical competencies: medium • analytical, design and implementation competencies: high • technological competencies: medium (C++, computer networks) • capability for scientific work: medium
Interdisciplinary competencies:	• project related competencies: depending on subject • interdisciplinary expertise: Basics in processing numerical data and its visualization • social and self-competencies: ability to work in a team

Economic and social management for engineers

English Title:	Economic and Social Management for Engineers
Document number:	41.4996
Language:	GERMAN
Assignment:	CNAM - Master cycle CNAM Master - Master cycle Master 2021 - Catalog SWK: Social Science Competencies Master 2013 - Catalog SWK: Social Science Competencies Master 2006 - Catalog S: Interdisciplinary Key Qualifications.
Teaching Form:	S = Seminar
SWS:	2
CP:	2.5
Examination:	Presentation with short paper or thesis paper; possibly final test/exam (will be announced in the first course).
Learning Objectives:	Learning Objectives: This course is designed to enable participants to, • Be able to assess the role of companies and businesses in the context of a changing economy and society • To be able to analyze the role of management of companies and businesses as part of an interdisciplinary leadership performance. • Be able to assess business decisions in terms of their sequence and significance • To be able to assess the importance of people as a resource for value creation and • The main management philosophies and management techniques of the Know and be able to apply the 20th century • Recognize corporate management and human resources management in their mutual relationship • Know and be able to apply principles of personnel leadership and management.
Course content:	Introduction: Economic and social framework conditions of Operations and development trends • Fundamentals and development of management theory (from Taylorism, Fordism to human relations and situational approaches). • Functions of management: Normative and strategic management, tactical and operational management.

- Human resources management and leadership
- Preliminary analyses for planning and decision-making: Representation techniques,
- Analysis techniques, creativity and problem solving techniques,
- Balanced Scorecard
- Shareholder Value versus Stakeholder Values
- Work organization and new forms of work design - with a focus on the IT sector
- Management of change: change management, organizational and personnel development
- Specifics of project management

Literature:	Strategic Management, Reisinger, Gattringer and Strehl, PEARSON Verlag, 2013. Organization and Project Management, Bergmann and Garrecht, Physica-Verlag, 2009 Psychological basics in the leadership process, Crisand, Sauer-Verlag,
2010Work forms / tools:	Seminar form, learning dialogue, group exercises
Department:	Computer Science
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Bernd Steffensen

Quality Management

Module numbers:	41.4876 [PVL 41.4877]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization SE: Software Engineering Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization SE: Software Engineering Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization SE: Software Engineering JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization SE: Software Engineering JIM 2006 - Courses Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization TS: Technical Systems MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+P = Lecture+Practical
Weekly hours:	2+1
Credit Points:	5
Exam:	oral exam
PVL (e.g. Practical):	not graded (ungraded practical)
Required knowledge:	English language skills
Learning objectives:	The students will learn the foundation of modern approaches to quality management at the organizational and project level. • They will become familiar with the principles and approaches for improvement of process and product quality. • They will learn to recognize management weaknesses and their consequences to quality.

	• They will also learn to read and interpret QM related literature such as standards.
Content:	Introduction; quality vs. efficiency; what is quality ? • Statistical process control (SPC) • Zero defects approach, quality management maturity grid (QMMI) • Deming's system of profound knowledge • Measuring performance vs. measuring quality • Total quality control / management (TQC, TQM) • Kaizen • The ISO 9000 Quality management system • Capability maturity model integration (CMMI)
Literature:	ISO 9000 standards family • CMMI for development • M.B.Chrissis, M. Konrad, S. Shrum: CMMI Guidelines for Process Integration and Product Improvement, Addison-Wesley Pearson, 3rd ed., 2011 • Gerald M. Weinberg. Quality Software Mamagent, Vol. 1-4, Dorset House Publishing, 1992. • M. Imai. Kaizen. The Key to Japan's Competitive Success. McGraw-Hill, 1986 • K. Ishikawa. What is Total Quality Control? The Japanese Way. Prentice Hall, 1985 • W. Edwards Deming. Out of the Crisis. MIT Press, 2000 • Philip B. Crosby. Quality is Free. McGraw-Hill, 1979 • W. A. Shewhart. Economic Control of Quality of Manufactured Product. 50th anniversary commemorative reissue, American Society for Quality, ASQ, 1980. • F. Taylor. Principles of Scientific Management. Harper & Brothers, New York and London, 1911. • Current research papers and case studies
Lecture style / Teaching aids:	Lecturewith workshop character, practical training in small groups, slides
Faculty:	Computer Science
Expert group:	Software engineering
Responsibility:	Alexander del Pino
Professional competencies:	formal, algorithmic, mathematical competencies: low • analytical, design and implementation competencies: low • technological competencies: high (quality management) • capability for scientific work: low
Interdisciplinary competencies:	• project related competencies: high • interdisciplinary expertise: basic economic competence

Real-Time Systems

Module numbers:	41.4878 [PVL 41.4879]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and system oriented modules Master 2021 - Catalog AS: Application and system oriented modules Dual Master 2013 - Catalog AS: Application and System Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphical Systems JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization TG: Technical and Graphical Systems JIM 2006 - Courses Master 2006 - Catalog AS: Application and system-oriented modules Master 2006 - Specialization TC: Telecommunications

	Master 2006 - Specialization TS: Technical Systems Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+P = Lecture+Practical
Weekly hours:	2+2
Credit Points:	6
Exam:	written exam
PVL (e.g. Practical):	not graded (ungraded practical)
Learning objectives:	Students will learn • how to differ between the properties and requirements of ordinary and real-time systems • the real-time systems theory on scheduling, worst-case execution times analysis, distributed real-time systems, real-time communication, real-time operating systems, etc. • how to model and analyze real-time systems • how to use this theory in real applications
Content:	Introduction to Real-Time Systems • Real-Time Scheduling • Real-Time Operating Systems (RTOS) • Applied Real-Time Scheduling • Real-Time Programming Languages • Synchronization • Real-Time Communication & Bus Systems • Standards for Real-Time Systems
Literature:	Andy Wellings, Alan Burns: Real-Time Systems and Programming Languages. - third edition, Pearson / Addison Wesley • Hans Hansson et al.: Real-Time Systens, Programme on Software Enginieering For Embedded Systems, Fraunhofer IESE and TU Kaiserslautern, Textbook E-M.6 • Giorgio C. Buttazzo: Hard Real-Time Computing Systems, Kluwer AP • Andrew S. Tanenbaum: Modern Operating Systems (3rd Edition), Pearson - Prentice Hall • Dieter Zöbel: Real-Time Systems - Fundamentals of Planning. Springer-Verlag 2008 • Hermann Kopetz: Real-Time Systems. Kluwer Academic Publishers • Etschberger, Konrad et.al.: Controller area network: Basics, protocols, chips and applications • Lawrenz, Wolfhard: CAN: Controller Area Network: Fundamentals, Design, Applications, Test Technology, VDE VERLAG
Lecture style / Teaching aids:	Seminaristiclecture with Powerpoint presentation with computer-aided examples as well as lecture hall exercises; in the practical course the understanding of the material of the event is supported and deepened with the help of experiments and programming tasks.
Faculty:	Computer Science
Expert group:	Computer engineering
Responsibility:	Ralf S. Mayer
Professional competencies:	formal, algorithmic, mathematical competencies: medium • analytical, design and implementation competencies: high • technological competencies: high (real-time systems, bus systems) • capability for scientific work: low
Interdisciplinary	

competencies:

- interdisciplinary expertise: basic technical and natural scientific competence

Reference Architectures and Patterns

Module numbers:	41.4880 [PVL 41.4881]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization SE: Software Engineering Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization SE: Software Engineering Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization SE: Software Engineering JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization SE: Software Engineering JIM 2006 - Courses Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization TS: Technical Systems MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+P = Lecture+Practical
Weekly hours:	2+2
Credit Points:	6
Exam:	oral exam
PVL (e.g. Practical):	not graded (ungraded practical)
Required knowledge:	Advanced programming experience (e.g., Java), sound knowledge in softwareengineering, in particular design experience; knowledge in design patterns
Learningobjectives:	Thestudents shall achieve the skills and proficiencies to be able to perform the following tasks: • design medium-size and large-scale industry standard business information systems, • design components and interfaces according to design principles, • apply object/relational mappings, • design and implements clients of business information systems, • implement professional exception handling, • apply design patterns and refactorings, • work with cloud native technologies, • understand the basic concepts of Business Intelligence (BI), Systems Integration (EAI) and Service-Oriented Architecture (SOA)
Content:	Software architecture principles • Industry standard architecture of large IT applications • Components and interfaces, software categories, architectural viewpoints • Reference architectures for business information systems: three-layer architecture, client architecture, application kernel architecture, persistence layer architecture • Security, error handling, logging, etc. • Software design patterns, refactoring catalogs • Reference architecture for service-oriented IT application landscapes (SOA) • Reference architecture for enterprise application integration (EAI), internet portals, security architectures • Reference architecture for business intelligence (BI) • Cloud native technology and architecture • Numerous examples from large-scale industrial IT projects

Literature:	Siedersleben: Modern Software Architecture. dpunkt-Verlag 2004 • Siedersleben et. al.: Quasar: The sd&m Standard Architecture • Haft, Humm, Siedersleben: The Architect's Dilemma - Will Reference Architectures Help? Additional reading: • Evans: Domain-driven design (aspect: tactical design) • Martin: Clean Architecture: A Craftsman's Guide to Software Structure and Design • Gamma et.al.: Design Patterns. Elements of Reusable Object-Oriented Software Basic reading: • Reussner, Hasselbring (Eds.): Handbuch der Software-Architektur. 2nd edition, dpunkt-Verlag 2009 • Ludewig, Lichter: Software Engineering. 3rd edition, dpunkt-Verlag 2013
Lecture style / Teaching aids:	Lecture, Internship, Slides, White Board, Integrated Development Environment, Books, Magazine Articles
Faculty:	Computer Science
Expert group:	Software engineering
Responsibility:	Markus Voß
Professional competencies:	formal, algorithmic, mathematical competencies: low • analytical, design and implementation competencies: high • technological competencies: high (architectural concepts, methodological knowledge)
Interdisciplinary competencies:	• project related competencies: low • interdisciplinary expertise: basic technical and natural scientific competence

Requirements Engineering and Management

Document numbers:	41.5022 [PVL 41.5023; Module 41.50220]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization SE: Software Engineering Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization SE: Software Engineering Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization SE: Software Engineering JIM 2013 - Elective Catalogue T Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization SE: Software Engineering Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching Form:	V+S = Lecture+Seminar
SWS:	3+1
CP:	6
Exam:	oral exam
PVL (e.g., internship):	Graded
Share PVL:	20%
Required prior knowledge:	Knowledge of UML
Learning Objectives:	After attending this course, the student will be able to

- independently perform system analyses,
- Requirements to be documented with the help

of modern techniques,
- Perform change management across the software

lifecycle,
- risk management,
- Introduce requirements engineering as a process.

In addition to the knowledge in the field of requirements engineering, the student will be able to
- Communicate with stakeholders and capture their goals,
- analyze and evaluate unstructured requirements. The

student has the ability to form models, simulate them and use them to develop software architectures that enable the transition to the software development process.

Course Content:

Lecture:
What is requirements engineering
- the context and the system solution
- Requirements categories
- Requirements Lifecycle
- Requirements Engineering and the Software Lifecycle
- Agile Processes and Requirements Engineering

Domain Understanding and Requirements Collection
- Stakeholder identification
- Artifact driven requirements collection
- Stakeholder-driven requirements collection
- Creativity Techniques

Requirements Evaluation
- Inconsistency management
- Risk analysis

Requirements specification and documentation
- Description in structured language
- Diagram based notations

Requirements Quality assurance
- Inspections and reviews
- Questionnaires
- Quality Metrics
- Modeling and Prototyping

Requirements Evolution
- Versioning and variants
- Anticipate changes
- Traceability
- Change Management

Goal Orientation
- what are Goals
- Granularity of Goals
- Goal types and catgories
- the central role of Goals

System modeling
- Modeling of system goals with Goal Diagrams
- Risk analysis on Goal models
- Modeling conceptual objects with class

diagrams
- Modeling System Agents and Responsibilities Seminar. In

the seminar, in-depth topics and techniques that are important for the collection and evaluation of requirements are covered and introduced to the students in a seminar-like manner.

	Cretivity techniques • Conversational • Negotiation Management • Risk Management
Literature:	Lecture: • Requirements engineering ; Axel van Lamsweerde ; John Wiley & Sons; 2009 • Requirements engineering and management ; Chris Rupp & die SOPHISTen ; Hanser Verlag; 2009 • Requirements engineering ; Klaus Pohl ; dpunkt Verlag; 2008 Seminar: • Bear Tango; Tom DeMarco, Tim Lister; Hanser Verlag; 2003 • Six Thinking Hats; Edward de Bono; Back Bay Books; 1999 • De Bono's new school of thought; Vera F. Birkenbihl; mvg; 2005 • The Harvard Concept; Roger Fisher, William Ury; Campus Verlag; 2004
Forms of work / resources:	Lecture with presentation, white board and script, seminar with Presentations and elaborations of the students
Department:	Computer Science
Professional group:	Software Engineering
Module responsibility:	Urs Andelfinger

Security of Web Applications

English title:	Security of Web Servers and Web Applications
Module numbers:	41.5040 [PVL 41.5041]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+P = Lecture+Practical
Weekly hours:	2+2
Credit Points:	6
PVL (e.g. Practical):	not graded
Required knowledge:	Development of web application in one of the following languages: PHP, Python, Java, Ruby, Go or NodeJS
Learning objectives:	The students are able to • summerize key points of SSDLC • explain common vulnerabilitites of web applications • identify vulnerabilities in web applications and create security fixes • perform security tests from an attackers point of view • develop secure web applications

	• analyze and evaluate the security level of web servers and web applications
Content:	secure software development life cycle (SSDLC) • identify and prevent security flaws like injections, XSS, insecure session management • identify and correct design flaws like usage of insecure cryptographic ciphers • design and implementation of logging and audit trails • technical procedures and tools for vulnerability identification • development of security fixes for a vulnerable application (hands-on task) • use a continuous integration (CI) environment • usage of version control systems like git and SVN • test applications deployed on a web server and review the configuration management of web servers
Lecture style / Teaching aids:	Fixing vulnerabilities in a web application and REST API. The student can choose one of the following programming languages for the course: PHP, Python, Java, Ruby, Go or NodeJS
Faculty:	Computer Science
Expert group:	IT Security
Responsibility:	Christoph Krauß
Professional competencies:	formal, algorithmic, mathematical competencies: low • analytical, design and implementation competencies: high • technological competencies: high • capability for scientific work: medium
Interdisciplinary competencies:	• project related competencies: high • interdisciplinary expertise: basic technical and natural scientific competence, basic juristic competence • social and self-competencies: ability to work in a team, analytical competence, judging competence, deciding competence, competence of knowledge acquisition, presentational, documentary, teaching and mentoring competence

Security Protocols and Infrastructures

Module numbers:	41.4886 [PVL 41.4887]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security JIM 2006 - Courses Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization IS: IT Security Master 2006 - Specialization TC: Telecommunications Master 2006 - Specialization TS: Technical Systems MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+Ü+P = Lecture+Exercise+Practical

Weekly hours:	2+1+1
Credit Points:	6
Exam:	written exam (90 min., with tasks from the master taskcatalog)
PVL (e.g. Practical):	not graded (Defending own solutions to given practical tasks)
Required knowledge:	IT Security; structured and analytical thinking. Further recommended: basic concepts and ways of thinking in the field of cryptography
Learning objectives:	After this course the students • have a deep understanding of design principles of security protocols and security infrastructures. • have knowledge of the basic security goals in cryptography and its relevance to practical use cases. • understand in which way well-known security protocols (TLS, PACE, EAC) achieve the security goals. • understand the key topics of the wide-spread security infrastructure standards and apply them to practical tasks. • are able to choose suitable protocols for a given use case. • are able to analyze if a security protocol does have the zero knowledge property. • can evaluate the security properties of security protocols and infrastructures.
Content:	Security goals (CIA) • Network security protocols (TLS) • Security protocols for electronic ID cards • Abstract Syntax Notation 1 (ASN.1) • Certificates and related standards X.509/RFC5280 • Public Key Cryptography Standard Series • Certificate-based security infrastructures (PKI) • Zero knowledge protocols • Practical and theoretical solutions to exercises • Autonomous acquisition of zero knowledge protocols, which will be treated in the exam
Literature:	Menezes, P. van Oorschoot, S. Vanstone: Handbook ofApplied Cryptography, CRC Press, 1997. • D. Cooper et.al.: Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile, Request for Comments 5280, May 2008. • T. Dierks et.al.: The Transport Layer Security (TLS) Protocol, Version 1.2, Request for Comments 5246, August 2008. • BSI Technical Report TR-03110,
www.bsi.bund.deLecture style / Teaching aids:	Lecture+ exercise + practical
course / further reading Faculty:	Computer Science
Expert group:	IT Security
Responsibility:	Alex Wiesmaier
Professional competencies:	formal, algorithmic, mathematical competencies: medium • analytical, design and implementation competencies: medium • technological competencies: medium • capability for scientific work: low
Interdisciplinary competencies:	• project related competencies: low • interdisciplinary expertise: basic technical and natural scientific competence

Service Oriented Architecture

Module numbers:	41.4890 [PVL 41.4891]
Language:	english
Study programme:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Dual Master 2021 - Specialization SE: Software Engineering Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization SE: Software Engineering Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization SE: Software Engineering JIM 2013 - Elective Catalogue J Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization SE: Software Engineering JIM 2006 - Courses Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Type of course:	V+P = Lecture+Practical
Weekly hours:	2+2
Credit Points:	6
Exam:	oral exam
PVL (e.g. Practical):	not graded (ungraded practical)
Requiredknowledge	: Necessary: basic UML, basic Java • Recommended: Advanced programming experience, software design experience (design patterns, refactoring, etc.), solid knowledge of software engineering, some software project experience
Learningobjectives:	Thestudents shall achieve the skills and proficiencies to be able to perform the following tasks: • analyze the business architecture of an enterprise, • analyze architectures of IT application landscapes, • apply rules for designing domains in IT application landscapes, • apply rules for designing components in IT application landscapes, • apply rules for designing services in a service-oriented architecture, • determine a suitable degree of coupling and design interfaces accordingly, • plan the managed evolution of IT application landscapes, • work with cloud native technologies, • use SOA technologies like web services, BPMN2 bases process automation and data integration
Content:	Enterprise architecture principles • Reference architecture for service-oriented IT application landscapes • Domains, components and interfaces in the large, component categories • Microservices, event driven architecture • Rules for designing components in the large • Services and service-oriented architecture [SOA] • Rules for designing services • Loose coupling • WS*-like and restful web services, service orchestration and choreography, BPMN2 basics and business process automation, data integration • Cloud native technology and architecture • Numerous examples from large-scale industrial IT projects
Literature:	Engels, Voß et.al.: Quasar Enterprise - Designing application landscapes in a service-oriented way. dpunkt-Verlag 2008.

	• Hess, Humm, Voß: Rules for High-Quality Service-Oriented Architectures. 2006 Additional reading: • Evans: Domain-driven design (strategic design) • Fowler: Patterns for Enterprise Application Architectures • Newman: Building microservices Basic reading: • Reussner, Hasselbring (Eds.): Handbuch der Software-Architektur. 2nd edition, dpunkt-Verlag 2009 • Ludewig, Lichter: Software Engineering. 3rd edition, dpunkt-Verlag 2013
Lecture style / Teaching aids:	Lecturewith workshop character, internship, blended learning, team work, slides, white board, wiki, integrated development environment, books, current journal articles
Faculty:	Computer Science
Expert group:	Software engineering
Responsibility:	Markus Voß
Professional competencies:	formal, algorithmic, mathematical competencies: low • analytical, design and implementation competencies: high • technological competencies: high (architectural concepts)
Interdisciplinary competencies:	• project related competencies: medium • social and self-competencies: ability to work in a team

Shader concepts for game development

English Title:	Shader Concepts for Games Engineering
Document numbers:	41.5096 [PVL 41.5097]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization TG: Technical and Graphic Systems Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization TG: Technical and Graphic Systems Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphic Systems Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	2+2
CP:	6
Exam:	Written exam (90 minutes)
PVL (e.g. practical course):	ungraded (ungraded [conception and development of an application software in groups of two])
Required prior knowledge:	Advanced programming skills in C/C++ or Java. • Basic knowledge in graphic data processing
Learning Objectives:	Students will: • Understand and be able to apply the basics of shader programming. • Understand the individual steps of the rendering pipeline, be able to set up and program the necessary calculations.

	• know and be able to implement a simple illumination calculation based on the Phong illumination model for different light sources. • Understand the theoretical basis of various texturing processes and be able to program some selected processes.
Course content:	The main focus of this module is on the integration and Programming of so-called shaders, i.e. small programs that are executed directly on the graphics card. With the help of these shaders, the rendering pipeline (chain of calculation steps for generating digital images and animations) will be successively implemented and understood. As an extension of the rendering pipeline, the basics of illumination and reflection calculation will be discussed using the Phong illumination model as an example and implemented in the accompanying labs. Furthermore, textures will be uploaded to the graphics board and processed there. In computer graphics, textures refer to images that are applied to the surface of 3D models. Textures, however, offer further application possibilities, for example, detailed surface textures of models can be simulated with little additional effort (for example, by normal or alpha mapping), or more complex illumination and reflection conditions can be precalculated once and stored in a texture.
Literature:	OpenGL documentation and current literature [see script]
Work forms / resources:	Lecture, script, exercises, supplementary examples
Department:	Computer Science
Professional group:	Multimedia and graphics
Module responsibility:	Benjamin Meyer
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: medium • Technological competencies: medium • Ability to work scientifically: weak

Security in multimedia systems and applications

Document Number:	20-00-0093iv
Language:	GERMAN
Assignment:	Dual Master 2021 - Specialization IS: IT Security (TUD) Master 2021 - Specialization IS: IT Security (TUD) Bachelor dual KITS 2014 - Catalogue ITS: IT Security Dual Master 2013 - Specialization IS: IT Security (TUD) Master 2013 - Specialization IS: IT Security (TUD)
Teaching form:	VP = Lecture with integrated practical course
SWS:	4
CP:	6
Department:	TU Darmstadt, FB20 Computer Science
Expert group:	IT Security

Situational leadership in the project

English Title:	Situational leadership in projects
Document numbers:	41.4916 [PVL 41.4917; Module 41.49160]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog SSK: Social and Personal Skills Master 2021 - Catalog SSK: Social and Personal Skills. Dual Master 2013 - Catalog SSK: Social and Self Competences Master 2013 - Catalog SSK: Social and Self Competences Master 2006 - Catalog S: Interdisciplinary Key Qualifications
Teaching form:	V+Ü = Lecture+Exercise
SWS:	2+2
CP:	5
Exam:	oral exam
PVL (e.g. internship):	graded(The PVL includes a graded project work (written elaboration and its presentation). The PVL is prepared in small groups. The PVL aims at the practical application and reflection of selected topics of the course).
PVL share:	50%
Required prior experience:	Knowledge as well as (desirable) practical experience in Project management.
Learning Objectives:	Students will • Get to know basic ideas of situational leadership and learn to apply them practically in a variety of practice situations, • Practice practical emotional competence (PEK) skills, • legitimately influence behavior and decisions in team situations by directly addressing emotions. To do this they should • understand why arguments alone are not convincing, • learn how emotions influence motives, fears and needs, • Understand the connection and interaction between the factual and emotional levels, • Practice active listening as a leadership tool, • train to identify conflicts early and integrate difficult employees, • train to question and deal with pretexts in a differentiated way, • learn to assert themselves even without a superior function, • train to make difficult decisions, • train to moderate groups in an open-ended and goal-oriented manner
Course content:	Four basic emotions and human behavior. • Conscious and unconscious behavior • Targeted addressing of the factual or emotional level • Language and its direct emotional impact • Self-reflection of one's own language, formulate actively and positively • Leadership through questions, active listening • Achieving commitment - how an employee's yes really becomes a yes • Team building as an ongoing process • Act authentically & assertively by understanding and addressing current motives, needs, or fears. • Accepted decisions - the really convincing formulation of your requirements for every employee in the team

- Moderating workshops - open-ended and goal-oriented
- Questioning and debunking pretexts: Recognizing and focusing on what is really at stake at the moment
- Building and consolidating natural authority - radiating competence and confidence
- Building and maintaining resilient relationships
- Self-awareness: optimally compensate for weaknesses - through individual preparation for meetings and conversations

Literature:

Quite simply convincing, Wolfgang Schneiderheinze and Carmen Zotta, Gabler 2009.

- Communicating quite simply, Wolfgang Schneiderheinze and Carmen Zotta, Gabler 2012
- What we are and what we could be: A Neurobiological Courager, Gerald Hüther, S. Fischer 2012
- Brain View. Why Customers Buy, Hans-Georg Häusel, Haufe 2008
- Gut decisions, Gerd Gigerenzer, Goldmann, 2008
- Emotional Intelligence, Daniel Goleman, dtv, 1997
- Thinking helps, but is of no use, Dan Ariely, Droemer, 2008
- Who wants to think, must feel: The Secret Power of Unreason, Dan Ariely, Knaur 2012
- The Seven Ways to Effectiveness, Stephen R. Covey, Campus, 1989

Forms of work / resources: Seminar-like lecture, high proportion of interaction especially for exercise and Consolidation. Presentation and elaboration for the PVL. Preferably conducted as a block course with 7 - 8 full teaching days, so that there is sufficient time for interactive practice of the contents.

Department: Computer Science

Division: Social and Cultural Aspects of Computer Science

Module responsibility: Urs Andelfinger

Cross-curricular competencies:

Cross-curricular subject competencies: Basic economic literacy, Competencies of scientific work from an interdisciplinary perspective

- Social and personal competencies: Leadership competence, ability to work in a team, analytical competence, judgment competence, decision-making competence, presentation, documentation, teaching and consulting competence, language competence.

Software Product Line Engineering

Module numbers: 41.5024 [PVL 41.5025]

Language: english

Study programme: Dual Master 2021 - Catalog AS: Application and System Oriented Modules
Dual Master 2021 - Specialization SE: Software Engineering
Master 2021 - Catalog AS: Application and System-Oriented Modules
Master 2021 - Specialization SE: Software Engineering
Dual Master 2013 - Catalog AS: Application and System-Oriented Modules
Dual Master 2013 - Specialization SE: Software Engineering
JIM 2013 - Elective Catalogue J
Master 2013 - Catalog AS: Application and System Oriented Modules
Master 2013 - Specialization SE: Software Engineering
Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering
MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.

Type of course: V+P = Lecture+Practical

Weekly hours:	2+2
Credit Points:	6
Exam:	oral exam
PVL (e.g. Practical):	not graded
Requiredknowledge:	Soundknowledge in software engineering; good programming skills
Learningobjectives:	The students shall achieve the following skills • to recognize software product lines in real-life projects and to propose appropriate solutions for the development • to recognize and to handle variability in projects (including analysis, design, realization and management) • to use advanced modeling techniques to express variability in common modeling artifacts (esp. UML diagrams) • to implement and to model reusable software with variability • to transfer the techniques from product line development to 'normal' projects
Content:	Product lines in nowadays industrial projects • Benefits and prerequisites of product line development • Relationship of product lines and software engineering • Modeling software that contains variability • Mechanisms for developing software that contains variability • Systematic and generic approach to product line development (Product line practices framework)
Literature:	Software Product Lines : Practices and Patterns, P. Clements, L. M. Northrop, Addison Wesley, 2001. • Software Product Line Engineering: K. Pohl, G. Böckle, F. van der Linden, Springer, 2005
Lecture style / Teaching aids:	Seminaristiclecture using slides, books and scientific articles
Faculty:	Computer Science
Expert group:	Software engineering
Responsibility:	Ralf Hahn
Professional competencies:	formal, algorithmic, mathematical competencies: low • analytical, design and implementation competencies: high • technological competencies: high • capability for scientific work: low
Interdisciplinary competencies:	• interdisciplinary expertise: basic economic competence

Technology philosophy

English Title:	Philosophy of Technology
Document number:	41.4924
Language:	GERMAN
Assignment:	Master 2021 - Catalog SWK: Social Science Competencies Master 2013 - Catalog SWK: Social Science Competencies Master 2006 - Catalog S: Interdisciplinary Key Qualifications.
Teaching Form:	S = Seminar
SWS:	2
CP:	2.5

Examination:	Presentation with short paper or thesis paper; possibly final test/exam (will be announced in the first course).
PVL (e.g., internship):	Continuous attendance, willingness to discuss
Learning Objectives:	Students will • Learning to reflect on and evaluate technology as a social phenomenon, • Get to know the classical texts and authors of the philosophy of technology, • gain a deeper understanding of "technology" - in the respective historical epochs and in the horizon of science, society and culture, • acquire methodological skills in the analysis, reflection and evaluation of different philosophies of technology, • learn to evaluate the philosophies of technology and the concepts of technology with regard to the options for shaping technology in society.
Course content:	The seminar starts with current problems in the field of society' s interaction with technology, for example in the field of robotics, synthetic biology or nanotechnology. This motivates the passage through history. It will be shown how the understanding of technology has changed historically: from an instrumentalistic to a more systemic and finally to a medial concept of technology. Content focus: • the Aristotelian understanding of technology • Bacon Lyrics • "Classics of the Philosophy of Technology" (in short excerpts): Marx, Kapp, Franklin, Bergson, Cassirer, Heidegger, Gehlen, Adorno/Horkheimer, Macuse, Ortega y Gasset, J. Ellul, M. Heidegger, G. Anders, H. Schelsky, Habermas, Jonas, Bunge and Lenk. • Texts on the current discussion: Feenberg, Ihde, Ropohl, Hubig, Gamm and Latour
Literature:	Hubig, C., Huning, A., Ropohl, G. (eds.), 2001: Thinking about technology. Die Klassiker der Technikphilosophie; Berlin. • Ropohl, G., 1979/1999: A Systems Theory of Technology. On the foundation of general technology. Munich/Vienna. • Rapp, F., 1994: The Dynamics of the Modern World. Hamburg. • Zoglauer, T. (ed.), 2002: Technikphilosophie, Freiburg. • Rammert, W. (ed.), 1998: Technik und Sozialtheorie; Opladen. • Bender, W., Schmidt, J.C. (eds.), 2003: Future-Oriented Science. Prospective Science and Technology Assessment, Münster.
Forms of work / resources:	Lecture (approx. 3 introductory hours), then seminar form
Department:	Computer Science
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Jan Schmidt
Supra-disciplinary competencies:	Project-related competencies: weak • Interdisciplinary subject competencies: Historical, social-scientific, ethical and philosophical basic competence, basic competence in the theory of science, competences of scientific work in a field outside the subject area. • Social and personal competencies: Competence to analyze, competence to judge, competence to make decisions, competence to acquire knowledge, competence to present, to document, to teach and to advise.

Text and web mining

English Title:	Text and Web Mining
Document numbers:	41.5042 [PVL 41.5043]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and system-oriented modules Master 2013 - Catalog AS: Application and system-oriented modules MN Data Science 2022/2016 - Catalog DS-I: Data Science - Computer Science.
Teaching form:	V+P = Lecture+Internship
SWS:	2+2
CP:	6
Exam:Written exam (Klausur)	
PVL (e.g. internship):	ungraded
RequiredPrevious knowledge:	Basicstatistics and programming is necessary. Of advantage or recommended as a supplement, but not mandatory: • Data Mining • Natural Language Processing • Semantic Web
Learning Objectives:	Students will: • Have an overview of what types of unstructured or semi-structured text & web data exist and how to obtain them. • Extract text and web data from common sources and be able to link and prepare it for further analysis. • Be able to identify and explain characteristics of specific text & web data sets. • Be able to apply statistical and machine learning methods to linked and processed text & web data to generate descriptive or predictive models. Be able to qualitatively and quantitatively assess the usefulness of text & web data with respect to a specific analysis goal.
Course Content:	The WWW as a data source: basic concepts of web content mining, web usage mining, web structure mining. • XML Technologies and Query Languages, Linked Data & Semantic Web • Crawling search strategies; Spider&Robot implementation • Generate website wrappers • Link Analysis & Community Detection • Text decomposition • Information Retrieval - Vector Space Model, Word Embeddings, N-Gram Models, Similarity Measures, Goodness Measures, Relevance Ranking. • Analytics and data mining on text & web data (vocabularies, sparsity, online leaning, deep learning). • Topic models

Literature:Current scientific publications at the time of the course, as well as:

- Liu, B. (2011), Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data. Second Edition , Springer .
- Heyer, G.; Quasthoff, U. & Wittig, T. (2006), Text Mining: Knowledge Raw Material Text. Concepts, Algorithms, Results , W3l .

- Manning, C. & Schütze, H. (1999), Foundations of statistical natural language processing , MIT Press .
- Manning, C.; Raghavan, P. & Schütze, H. (2008), Introduction to Information Retrieval , Cambridge University Press.
- Mitchell, R. (2015), Web Scraping with Python: Collecting Data from the Modern Web, O'Reilly.
- Munzert, S.; Rubba, C.; Meißner, P. & Nyhuis, D. (2015), Automated Data Collection with R: A Practical Guide to Web Scraping and Text Mining, Wiley.
- Russell, M. A. (2018), Mining the Social Web, O'Reilly.
- Christen, P. (2012), Data Matching, Springer.
- Harrison, P. & Honnibal, M. (2018), Deep Learning with Text: A Modern Approach to Natural Language Processing with Python and Keras, O'Reilly.

Forms of work / resources:	Lecture possibly with workshop character, practical course, team work, slides, Whiteboard, live coding
Department:	Computer Science
Expert Group:	Data Science
Module responsibility:	Markus Döhring
Subject Competencies:	Formal, algorithmic, mathematical competencies: medium • Analysis, design and implementation skills: high • Technological competencies: medium (development process, strategic use of tools, quality assessment of models and results) • Ability to work scientifically: weak
Supra-disciplinary competencies:	Project-related competencies: medium • Cross-curricular subject competencies: Basic technical and scientific competencies • Social and personal competencies: Analysis competence, judgment competence, decision-making competence.

In-depth R&D studies

English Title:	Independent R&D Studies
Document number:	41.4974
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Catalog AS: Application and System Oriented Modules Master 2006 - Catalog AS: Application and System Oriented Modules Master 2006 - Specialization AE: Application Engineering Master 2006 - Specialization TC: Telecommunications Master 2006 - Specialization TS: Technical Systems Master 2006 - Specialization WI: Business Informatics MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching Form:	S = Seminar
CP:	6
Examination:	Written elaboration
PVL (e.g. internship):	Ungraded preliminary examinations (e.g. documentation of project work, seminar presentation, or written papers) will beannounced at the beginning of thecourse. Regular and successful participation in R&D meetings with the supervising professor.

Document Requirement:	Written acceptance from the supervising professor. Professor of the FB I
Learning objectives:The	aim of the module is the independent familiarization with a current research field, as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the master's thesis. The contents must be agreed upon in advance with the supervising lecturer. Master's students acquire in-depth and specialized R&D skills: • Ability to conduct independent scientific work, e.g. independently research and compile relevant specialist literature on a specific complex of topics in computer science, familiarize oneself with it, and carry out a source-critical evaluation and analysis of the specialist literature. • Ability to research, develop and implement concepts such as. e.g. independently evaluate, implement, and test algorithms, solution approaches, technologies, and procedures; e.g. independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance. • Ability to write, publish and present of scientific work, such as independently writing a scientifically sound written paper on a specific complex of topics in computer science, writing a research proposal, preparing system documentation. • Ability to recognize differences between your own results and those of others. (plagiarism detection and plagiarism prevention) Other competencies that can be acquired by the master's student in this course, for example: • Methodological competencies, such as independently researching and compiling relevant specialist literature on a specific complex of topics in computer science, familiarizing oneself with it, and carrying out a source-critical evaluation and analysis of the specialist literature. • Evaluation skills, such as independently evaluating algorithms, approaches, technologies, and procedures, • Project management skills, such as planning R&D projects (including milestone plan, work breakdown structure, budget planning) and conducting feasibility studies, • Innovation management skills, such as being able to use and execute creative techniques and protect innovations through intellectual property rights • Solution skills, such as independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance. • Writing and research skills, such as independently writing a research-based written paper on a specific computer science topic, writing a research proposal, preparing system documentation. • Communication skills, such as didactically designing and delivering a lecture on a specific computer science topic using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively contributing to the discussion on specific computer science topics in a well-founded manner; giving presentations at conferences. • Social and personal skills, such as leadership skills, teamwork skills, Analysis competence, judgment competence, decision-making competence, competence

	for knowledge acquisition, presentation, documentation, teaching and consulting skills
Course content:	The topic of the in-depth R&D studies is based on current research and development projects of the lecturer and must be agreed upon individually with the student. The lecturer offers an in-depth R&D study according to the following three alternatives: • Individual Study (with independent R&D study work) • Individual Production (collaboration and practical implementation in R&D project with final project report) • Supervised Research (with peer-reviewed R&D paper)
Literature:	Will be announced at the beginning of the course
Forms of work / resources:	Self-study, problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications.
Department:	Computer Science
Module responsibility:	Michael Massoth

In-depth R&D studies IS

English Title:	Independent R&D Studies IS
Document number:	41.5058
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization IS: IT Security Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization IS: IT Security Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization IS: IT Security Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization IS: IT Security
Teaching Form:	S = Seminar
CP:	6
Examination:	Written elaboration
PVL (e.g. internship):	Ungraded preliminary examinations (e.g. documentation of project work, seminar presentation, or written papers) will beannounced at the beginning of thecourse. Regular and successful participation in R&D meetings with the supervising professor.
Document Requirement:	Written acceptance from the supervising professor. Professor of the FB I
Learning objectives:The	aim of the module is the independent familiarization with a current research field, as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the master's thesis. The contents must be agreed upon in advance with the supervising lecturer. Master's students acquire in-depth and specialized R&D skills: • Ability to conduct independent scientific work, e.g. independently researching relevant literature on a specific subject matter

research, compile and familiarize themselves with computer science, as well as carry out a source-critical evaluation and analysis of the specialist literature.
- Ability to research, develop and implement concepts such as.
  e.g. independently evaluate, implement, and test algorithms, solution approaches, technologies, and procedures; e.g. independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance.
- Ability to write, publish and present
  of scientific work, such as independently writing a scientifically sound written paper on a specific complex of topics in computer science, writing a research proposal, preparing system documentation.
- Ability to recognize differences between your own results and those of others. (plagiarism detection and plagiarism prevention)

Other competencies that can be acquired by the master's student in this course, for example:

- Methodological competencies, such as independently researching and compiling relevant specialist literature on a specific complex of topics in computer science, familiarizing oneself with it, and carrying out a source-critical evaluation and analysis of the specialist literature.
- Evaluation skills, such as independently evaluating algorithms, approaches, technologies, and procedures,
- Project management skills, such as planning R&D projects (including milestone plan, work breakdown structure, budget planning) and conducting feasibility studies,
- Innovation management skills, such as being able to use and execute creative techniques and protect innovations through intellectual property rights
- Solution skills, such as independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance.
- Writing and research skills, such as independently writing a research-based written paper on a specific computer science topic, writing a research proposal, preparing system documentation.
- Communication skills, such as didactically designing and delivering a lecture on a specific computer science topic using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively contributing to the discussion on specific computer science topics in a well-informed manner; giving presentations at conferences.
- Social and personal skills, such as leadership skills, teamwork skills, Analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence

Course content:

The topic of the in-depth R&D studies is based on the lecturer's current research and development projects and must be agreed individually with the student. The lecturer offers an in-depth R&D study in the IT security environment according to the following three alternatives:

- Individual Study (with independent R&D study work)
- Individual Production (collaboration and practical implementation in R&D project with final project report)
- Supervised Research (with peer-reviewed R&D paper)

Literature:

Will be announced at the beginning of the course

Forms of work / resources:	Self-study, problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications.
Department:	Computer Science
Module responsibility:	Michael Massoth

In-depth R&D studies SE

English Title:	Independent R&D Studies SE
Document number:	41.5060
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization SE: Software Engineering Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization SE: Software Engineering Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization SE: Software Engineering Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Specialization SE: Software Engineering
Teaching Form:	S = Seminar
CP:	6
Examination:	Written elaboration
PVL (e.g. internship):	Ungraded preliminary examinations (e.g. documentation of project work, seminar presentation, or written papers) will beannounced at the beginning of thecourse. Regular and successful participation in R&D meetings with the supervising professor.
Document Requirement:	Written consent from the supervising professor. Professor of the FB I
Learning objectives:The	aim of the module is the independent familiarization with a current research field, as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the master's thesis. The contents must be agreed upon in advance with the supervising lecturer. Master's students acquire in-depth and specialized R&D skills: • Ability to conduct independent scientific work, e.g. independently research and compile relevant specialist literature on a specific complex of topics in computer science, familiarize oneself with it, and carry out a source-critical evaluation and analysis of the specialist literature. • Ability to research, develop and implement concepts such as. e.g. independently evaluate, implement, and test algorithms, solution approaches, technologies, and procedures; e.g. independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance. • Ability to write, publish and present of scientific work, such as independently writing a scientifically sound written paper on a specific complex of topics in computer science, writing a research proposal, preparing system documentation.

- Ability to identify differences between own and third party results (plagiarism detection and plagiarism avoidance)

Other competencies that can be acquired by the master's student in this course, for example:

- Methodological competencies, such as independently researching and compiling relevant specialist literature on a specific complex of topics in computer science, familiarizing oneself with it, as well as carrying out a source-critical evaluation and analysis of the specialist literature.
- Evaluation skills, such as independently evaluating algorithms, approaches, technologies, and procedures,
- Project management skills, such as planning R&D projects (including milestone plan, work breakdown structure, budget planning) and conducting feasibility studies,
- Innovation management skills, such as being able to use and execute creative techniques and protect innovations through intellectual property rights
- Solution skills, such as independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance.
- Writing and research skills, such as independently writing a research-based written paper on a specific computer science topic, writing a research proposal, preparing system documentation.
- Communication skills, such as didactically designing and delivering a lecture on a specific computer science topic using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively contributing to the discussion on specific computer science topics in a well-founded manner; giving presentations at conferences.
- Social and personal skills, such as leadership skills, teamwork skills, Analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence

Course content: The topic of the in-depth R&D studies is based on current research and development projects of the lecturer and must be agreed upon individually with the student. The lecturer offers an in-depth R&D study in the software engineering environment according to the following three alternatives:

- Individual Study (with independent R&D study work)
- Individual Production (collaboration and practical implementation in R&D project with final project report)
- Supervised Research (with peer-reviewed R&D paper)

Literature: Will be announced at the beginning of the course

Forms of work / resources: Self-study, problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications.

Department: Computer Science

Module responsibility: Michael Massoth

In-depth R&D studies TG

English Title:	Independent R&D Studies TG
Document number:	41.5062
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System-Oriented Modules Dual Master 2021 - Specialization TG: Technical and Graphic Systems Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization TG: Technical and Graphic Systems Dual Master 2013 - Catalog AS: Application and System-Oriented Modules Dual Master 2013 - Specialization TG: Technical and Graphic Systems Master 2013 - Catalog AS: Application and System-Oriented Modules Master 2013 - Specialization TG: Technical and Graphic Systems
Teaching Form:	S = Seminar
CP:	6
Examination:	Written elaboration
PVL (e.g. internship):	Ungraded preliminary examinations (e.g. documentation of project work, seminar presentation, or written papers) will beannounced at the beginning of thecourse. Regular and successful participation in R&D meetings with the supervising professor.
Document Requirement:	Written consent from the supervising professor. Professor of the FB I
Learning objectives:The	aim of the module is the independent familiarization with a current research field, as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the master's thesis. The contents must be agreed upon in advance with the supervising lecturer. Master's students acquire in-depth and specialized R&D skills: • Ability to conduct independent scientific work, e.g. independently research and compile relevant specialist literature on a specific complex of topics in computer science, familiarize oneself with it, and carry out a source-critical evaluation and analysis of the specialist literature. • Ability to research, develop and implement concepts such as. e.g. independently evaluate, implement, and test algorithms, solution approaches, technologies, and procedures; e.g. independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance. • Ability to write, publish and present of scientific work, such as independently writing a scientifically sound written paper on a specific complex of topics in computer science, writing a research proposal, preparing system documentation. • Ability to recognize differences between your own results and those of others. (plagiarism detection and plagiarism prevention) Other competencies that can be acquired by the master's student in this course, for example: • Methodological competencies, such as independently reading relevant technical literature on a specific complex of topics in computer science

research, compile, familiarize themselves with, and undertake a source-critical evaluation and analysis of the specialist literature
- Evaluation skills, such as independently algorithms, solution approaches, Evaluate technologies, and processes,
- Project management skills, such as planning R&D projects (including milestone plan, work breakdown structure, budget planning) and conducting feasibility studies,
- Innovation management skills, such as being able to use and execute creative techniques and protect innovations through intellectual property rights
- Solution skills, such as independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance.
- Writing and research skills, such as independently writing a research-based written paper on a specific computer science topic, writing a research proposal, preparing system documentation.
- Communication skills, such as didactically designing and delivering a lecture on a specific computer science topic using appropriate media; discussing scientific results (preferably in English) in a scientific community, actively contributing to the discussion on specific computer science topics in a well-informed manner; giving presentations at conferences.
- Social and personal skills, such as leadership skills, teamwork skills, Analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence

Course content:	The topic of the in-depth R&D studies is based on current research and development projects of the lecturer and must be agreed individually with the student. The lecturer offers an in-depth R&D study in the environment of Technical and Graphic Systems according to the following three alternatives: • Individual Study (with independent R&D study work) • Individual Production (collaboration and practical implementation in R&D project with final project report) • Supervised Research (with peer-reviewed R&D paper)
Literature:	Will be announced at the beginning of the course
Forms of work / resources:	Self-study, problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications.
Department:	Computer Science
Module responsibility:	Michael Massoth

In-depth R&D studies WI

English Title:	Independent R&D Studies BI
Document number:	41.5064
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and system-oriented modules Dual Master 2021 - Specialization WI: Business Information Systems. Master 2021 - Catalog AS: Application and System-Oriented Modules Master 2021 - Specialization WI: Business Informatics Dual Master 2013 - Catalog AS: Application and system-oriented modules Dual Master 2013 - Specialization WI: Business Informatics

	Master 2013 - Catalog AS: Application and System-oriented Modules Master 2013 - Specialization WI: Business Informatics
Teaching Form:	S = Seminar
CP:	6
Examination:	Written elaboration
PVL (e.g. internship):	Ungraded preliminary examinations (e.g. documentation of project work, seminar presentation, or written papers) will beannounced at the beginning of thecourse. Regular and successful participation in R&D meetings with the supervising professor.
Document Requirement:	Written acceptance from the supervising professor. Professor of the FB I
Learning objectives:The	aim of the module is the independent familiarization with a current research field, as well as the acquisition of in-depth R&D special knowledge, in particular (also) as preparation for the master's thesis. The contents must be agreed upon in advance with the supervising lecturer. Master's students acquire in-depth and specialized R&D skills: • Ability to conduct independent scientific work, e.g. independently research and compile relevant specialist literature on a specific complex of topics in computer science, familiarize oneself with it, and carry out a source-critical evaluation and analysis of the specialist literature. • Ability to research, develop and implement concepts such as. e.g. independently evaluate, implement, and test algorithms, solution approaches, technologies, and procedures; e.g. independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance. • Ability to write, publish and present of scientific work, such as independently writing a scientifically sound written paper on a specific complex of topics in computer science, writing a research proposal, preparing system documentation. • Ability to recognize differences between your own results and those of others. (plagiarism detection and plagiarism prevention) Other competencies that can be acquired by the master's student in this course, for example: • Methodological competencies, such as independently researching and compiling relevant specialist literature on a specific complex of topics in computer science, familiarizing oneself with it, and carrying out a source-critical evaluation and analysis of the specialist literature. • Evaluation skills, such as independently evaluating algorithms, approaches, technologies, and procedures, • Project management skills, such as planning R&D projects (including milestone plan, work breakdown structure, budget planning) and conducting feasibility studies, • Innovation management skills, such as being able to use and execute creative techniques and protect innovations through intellectual property rights • Solution skills, such as independently perform conceptualization, system design, implementation, integration, testing, evaluation, and quality assurance. • Writing and scientific skills, such as independently writing a

Write scientifically sound written paper on a specific computer science topic, write research proposal, prepare system documentation.
- Communication skills, such as giving a presentation on a particular Didactically design and deliver didactic lectures on computer science topics using appropriate media; discuss scientific results (preferably in English) in a scientific community, contribute actively and in a well-founded manner to discussions on specific computer science topics; give presentations at conferences.
- Social and personal skills, such as leadership skills, teamwork skills, Analysis competence, judgment competence, decision-making competence, knowledge acquisition competence, presentation, documentation, teaching and consulting competence

Course content:	The topic of the in-depth R&D studies is based on current research and development projects of the lecturer and must be agreed upon individually with the student. The lecturer offers an in-depth R&D study in the business informatics environment according to the following three alternatives: • Individual Study (with independent R&D study work) • Individual Production (collaboration and practical implementation in R&D project with final project report) • Supervised Research (with peer-reviewed R&D paper)
Literature:	Will be announced at the beginning of the course
Forms of work / resources:	Self-study, problem-oriented learning (POL), teamwork, R&D project work, case studies, lecture using current media, scientific publications.
Department:	Computer Science
Module responsibility:	Michael Massoth

Cellular networks

English Title:	Cellular Networks
Document numbers:	41.4906 [PVL 41.4907]
Language:	GERMAN
Assignment:	Dual Master 2021 - Catalog AS: Application and System Oriented Modules Master 2021 - Catalog AS: Application and System Oriented Modules. Dual Master 2013 - Catalog AS: Application and System Oriented Modules Master 2013 - Catalog AS: Application and System Oriented Modules Master 2006 - Catalog AS: Application and System Oriented Modules MN Data Science 2022/2016 - Catalog M-I_I: General Computer Science Elective.
Teaching form:	V+P = Lecture+Internship
SWS:	3+1
CP:	6
Exam:	Written exam
PVL (e.g. internship):	ungraded (PVL not graded)
RequiredPrior knowledge:	Basicsin Computer Networks, e.g., LV 30.7102
Learning objectives:	After taking this course, students will understand the • architecture of modern cellular networks such as 4G, 5G and beyond, • fundamentals of radio propagation, user mobility and mobile data traffic,

- basic approaches and functions to cope with these dynamics in the air interface, the radio access network and the cellular network,
- computation of fundamental performance bounds as well as the critical interpretation of key performance metrics, and
- basic hardware and software tools for testing, measuring and developing functions and protocols in cellular networks.

Course content:

Architecture of IP-based cellular networks: subnets, layers, core functions in 4G, 5G and beyond
- Radio channel and signals: Wave propagation, statistical channel models, multi-carrier modulation and error correction, multi-antenna systems, measuring RSSI and approximating path loss
- Performance bounds: wireless channel capacity, diversity-multiplexing tradeoff
- Link layer and medium access control: framing, hybrid ARQ protocols, scheduling algorithms, measuring throughput and interference
- User mobility: handover, interference coordination, mobile traffic dynamics
- Cellular network planning: Frequency reuse, key parameters and factors, data and tools for network planning, solving a simple planning problem
- Performance metrics: Essential metrics and statistics, throughput vs. latency, performance vs. fairness, metric computation and critical interpretation

Literature:

David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, available online, 2005.
- Mischa Schwartz, Mobile Wireless Communications, Cambridge University Press, 2005
- Further references will be provided during the lecture

The course will take place in the 5GLab. We will use special hardware such as software-defined radios and a core network emulator but students can also measure with their own mobile phones and laptops.

Department: Computer Science

Professional group: Telecommunications

Module responsibility: Stefan Valentin

Subject Competencies:

Formal, algorithmic, mathematical competencies: medium
- Analysis, design and implementation skills: medium
- Technological competencies: high
- Ability to work scientifically: weak

Cross-curricular competencies:

Cross-curricular competencies: Technical and basic scientific literacy

Future of work - work in the future

English Title: The Future of Work and Labor

Document number: 41.4926

Language: GERMAN

Assignment: Master 2021 - Catalog SWK: Social Science Competencies Master 2013 - Catalog SWK: Social Science Competencies Master 2006 - Catalog S: Interdisciplinary Key Qualifications.

Teaching Form: S = Seminar

SWS: 2

CP: 2.5

Examination:	Presentation with thesis paper and writtenelaboration
PVL (e.g. practical course):	Regular participation in the course
Learning Objectives:	Students will: • Gain an overview of the theories of social and cultural change in work, • be able to analyze and evaluate the normative premises of professional work, • acquire methodological knowledge to analyze the formations of the global division of labor in the IT sector, • Be able to evaluate the fluidity of employment relationships from multiple perspectives.
Course content:	Analysis of the forms of international, global division of labor, the concepts and organizational forms of work, new forms of business, industrial relations, the opportunities and risks of new forms of work and their significance for all areas of life.
Literature:	Castells, M. (2001-2003), The Information Age I-III, Opladen; • Hürtgen, St. U.a. (2009), From Silicon Valley to Shenzhen, Hamburg. • Kocka, J./Offe C. (eds.) (2001), Geschichte und Zukunft der Arbeit, Frankfurt. • Roubini, N./ Mihm, St. (2010), The End of the Global Economy and its Crisis, Frankfurt • Senett, R. (2012), Collaboration, Berlin
Forms of work / resources:	Seminarwith integrated lecture components, case studies, current statistics
Department:	Computer Science
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Ulrike Teubner
Supra-disciplinary competencies:	Project-related competencies: weak • Interdisciplinary subject competencies: Basic social science competencies with interdisciplinary connections, competencies of scientific work from an interdisciplinary perspective • Social and personal competencies: Ability to work in a team, analysis competence, judgment competence, knowledge acquisition competence, presentation and documentation competence.

Future dimensions of computer science and engineering professions

English Title:	Future Requirements for Professionals in Computer Sciences and Engineering
Document Number:	41.4928
Language:	GERMAN
Assignment:	Master 2021 - Catalog SWK: Social Science Competencies Master 2013 - Catalog SWK: Social Science Competencies Master 2006 - Catalog S: Interdisciplinary Key Qualifications.
Teaching Form:	S = Seminar
SWS:	4
CP:	5
Examination:	Forms of examination • Part A: Reception of the presentations / interviews of the expert speakers and critical discussion • Part B: Texts / Reports / Documentations / Presentations

PVL (e.g. internship):	Documentations, protocols, seminar presentation.
RequiredPrevious knowledge:	Interest in future-oriented questions and their scientific penetration
Learning Objectives:	Learning Objectives Part A: • Participants should be able to make judgments about future developments in the post-industrial and knowledge society and assess their significance for the profession of computer scientists and engineers. • Participants will practice scientific reflection and methodology based on the content of the course. • They should acquire knowledge and skills to responsibly carry out and further develop their profession in new institutional, legal and political frameworks. Learning Objectives Part B: • The participants should be able to orientate themselves in future-relevant topics and to develop conclusive arguments that make a debate about points of view possible. • They are to scientifically prepare findings and information from topics relevant to the future and also for a Be able to communicate intelligibly orally and in writing to non-specialist audiences. • The aim is also to improve the professional's ability to act. computer scientist or engineer in relation to future challenges in organizations and in societal contexts.
Course contents:	Part A: The course contains an interdisciplinary and integrative Program for the scientific penetration of future problems in an interdisciplinary perspective. For this purpose, expert and renowned representatives of the various disciplines were recruited for lectures, which were recorded as e-lectures. In order to enable "blended learning", the lectures from the various disciplines are made available to the students via an e-learning portal for the duration of the course. The students receive the contents of lectures on the computer and then discuss them together with the speakers in a presence phase at the university. Speakers come from the technical sciences, social sciences, law and philosophy / ethics, and economics. The focus is both national and international. Further specialized lectures are developed and continuously fed into the concept. Part B: This is about: • a summary and reproduction of the contents of the technical presentations, • an analysis and interpretation of the specialized lectures, • the critical discussion of the specialized lectures, • creative brainstorming within the framework of the topic areas, • Argumentation, style and logic, • Rhetoric, shaping of language and scientific texts, • Designing communication and text patterns and communication situations that are audience-engaging, understandable, and effective.
Literature:	Friedman, Thomas L. The World is Flat: A Brief History of the 21st Century. Jahrhunderts, Suhrkamp Verlag, 2008. • Friedman, Thomas L. What to do: An Agenda for the 21st Century, Suhrkamp Verlag, 2010.

- Graeber, David Debts: The first 5000 years. Klett-Cotta; 7th edition 2012
- Hobsbawm, Eric The Face of the 21st Century: Munich: Carl Hanser, 2nd edition: 2000.
- Hobsbawm, Eric The Age of Extremes: World History of the 20th Century, Deutscher Taschenbuch Verlag, 1998.
- Kornmeier, Martin Scientific writing made easy. For bachelor, master and dissertation. UTB, 2012.
- Stiglitz, Joseph The Opportunities of Globalization. Munich: Siedler-Verlag, 2008.
- Schneider, Wolf Deutsch fürs Leben. Hamburg: Rowohlt, 2002.
- Werder von, Lutz Textbook of creative writing. Matrix Publishing House, 2007
- Werder von, Lutz Lehrbuch des wissenschaftlichen Schreibens. Berlin: Schibri-Verlag, 1993

Forms of work / resources:	Part A: technical lectures engineer in the 21st century. blended learning and its reception and discussion. Seminaristic teaching Part B: Scientific work and scientific texting. Exercises in text writing, communication and rhetoric.
Department:	Computer Science
Division:	Social and Cultural Aspects of Computer Science
Module responsibility:	Kai Schuster
Cross-curricular competencies:	Cross-curricular competencies: Technical and basic competence in natural sciences, basic competence in economics and law, competences of scientific work from an interdisciplinary point of view • Social and personal competencies: Analytical competence, judgment competence, Decision-making competence, competence to acquire knowledge, presentation, documentation, teaching and consulting competence, language competence.