Modules International Programme School of Informatics

Reutlingen University, Fakulty of Informatics

Effective November 2020

Content

Bachelor:

Module:	Aspects of Communication	
Code:	mkiB73	
Subtitle:		
Course elements:	Seminar	
Semester:	Every semester	
Module coordinator:	Prof. Benjamin Himpel	
Lecturer:	Prof. Benjamin Himpel	
Language:	German, English	
Allocation to the curriculum:	Media and Communication Informatics (Bachelor's), compulsory subject, 7th semester	
Mode of teaching/semester hours per week (SWS):	Lectures	2 SWS
Total hours:	Contact time Independent study	30 hours 120 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisites:	None	
Mode of assessment:	Seminar: Presentation, ungraded	

Module objectives:

This module is designed to introduce students to scientific and research-based methodsof working as an accompaniment to their Bachelor's theses, so that they are able to view developed applications or applications in development in the context of research activity. In this context, research and development typically refer to applied research approaches of the type often found in industry. In addition to applied research, the module looks at more principles-based research and examines the differences between the two approaches.

Learning outcomes:

Knowledge:

- Be familiar with formats and methods in the field of applied research.
- Be familiar with licensing models.
- Be familiar with the scientific community and the opportunities for publishing research findings.
- Be able to use format templates.
- Be able to give feedback in the style of a peer review.
- Be able to contextualise scientific articles and studies from own area of development.
- Be able to evaluate own applications for future developments.
- Be able to research information on the subject of patents and utility models.

Skills:

Students become familiar with methods of publishing conference papers, for example. The module covers the whole process from producing a paper to submitting it via electronic conference systems. In a fictitious conference setting, students submit their own conference paper and have it reviewed and evaluated by their fellow students. Additionally, students are encouraged to submit a paper to a real conference or other scientific publication formats.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Assess their own developments and abilities in comparison to others.	Presentation, discussion
LO2	Give constructive feedback on developments.	Discussion
LO3	Produce a paper in a format that will enable it to be accepted at a conference.	Presentation, discussion
LO4	Benefit from enhanced information-related skills, particularly with regard to information retrieval methods for patents and utility models, for instance.	Presentation
LO5	Evaluate and apply licensing models for a range of artifacts.	Presentation, discussion

Content:

This module takes the format of a seminar. Students are required to participate by giving presentations and other papers in oral and written format (LO1). Working on the basis

of their own research work, usually carried out in relation to their Bachelor's thesis, students learn about options for publishing their findings (LO3). By creating and using a conference system to assess papers, students learn the possibilities presented by the peer review system (LO2). In this context, students use a conference system fora fictitious conference, providing a practical scenario in which they can not only review papers themselves, but also have their papers reviewed by others. Concluding the moduleis the subject of information retrieval, particularly where this concerns patent information (LO4). Rounding off this component relating to information skills are subjects such as open access and licensing models including Creative Commons (LO5). By giving presentations on methodological processes and bringing together their findings, students report on the methods they have used, their experiences, and how their findings can be used in the future (LO1).

Literature:

- Esselborn-Krumbiegel, Helga (2008): Von der Idee zum Text. Eine Anleitung zum wissenschaftlichen Schreiben. 3rd edition, revised. Paderborn, Munich, Vienna, Zurich: Schöningh (utb.de Bachelor-Bibliothek, 2334: Schlüsselkompetenzen, Kernkompetenzen).
- Kuhlen, Rainer; Semar, Wolfgang; Strauch, Dietmar (Hg.) (2014): Grundlagen der praktischen Information und Dokumentation. Handbuch zur Einführung in die Informationswissenschaft und -praxis. 6th edition, fully revised. Berlin: De Gruyter.
- Students will be informed of other sources of literature on the subjects of patient information, Creative Commons and software licences during the course of the module.

Module:	Business Modelling	
Code:	WIBW	
Subtitle:		
Course elements:	Lectures	
Semester:	Every semester	
Module coordinator:	Prof. Dr. Phiipp Zeise	
Lecturer:	Prof. Dr. Phiipp Zeise	
Language:	English	
Allocation to the curriculum:	Compulsory subject, 7th semester	
Mode of teaching/semester hours per week (SWS):	Lectures	4 SWS
Total hours:	Contact time Independent study	60 hours 90 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisites:	None	
Mode of assessment:	Lectures: Project work, presentation	

Module objectives:

This module aims to teach students methodological approaches to standard software systems and create an integrated picture of the knowledge they have acquired in the modules studied up to this point. It examines a company scenario from a range of perspectives. This process starts by analyzing and modeling business processes relating to sales and dispatch, material planning, purchasing and stock management, production planning, controlling, and financial accounting. Using a standard ERP system, students work through this scenario at user level on the basis of an example company. The next step involves the students modeling their own companies, adopting the perspective of a businessconsultant.

Learning outcomes:

Knowledge:

- Knowledge of a comprehensive methodological approach to introducing standard software systems in companies.
- Understanding of and ability to implement project planning and project management methods.Familiarity with and ability to implement technical project design including business process modeling, test case-driven customization and documentation methodology.
- Ability to adopt a complete overview of integrated company processes.

Skills:

Students learn how to select and use strategic project methods in the context of introducing and usingstandard software. They are able to design project plans within complex environments and create multifunctional standard software. In doing so, they are able to incorporate areas where various areasof work intersect in order to prevent unoccupied time in the project schedule. This requires productiveproject work in a team setting. Students carry out a systematic analysis of error situations. Creating documentation relating to the project work within the team as the project is progressing hones cognitive, practical and communication skills that allow knowledge to be applied

Competencies:

Systematic production of project findings according to a schedule. Handling stressful situations, methods for finding solutions in the complex project environment associated with a comprehensivestandard system. Developing solutions for previously unrecognized technical problems within a business, using all the sources available. Teamwork and self-discipline when working with other students

Content:

Seminar format:

Business process models are derived from various product and production strategies, and described on the basis of a standard method that can be applied in practice. Students develop not only a basis for subsequent processing in the standard ERP system, but also sample navigation models for variouslogistics situations.

Project work:

Standard software is used to map out various aspects of a model organization, in the areas

of sales and dispatch, material planning, purchasing and stock management, production planning, controlling,and financial accounting.

This is carried out in small sub-projects, familiarizing students with the process of organizing project groups. Supplementing this process is methodological knowledge in the areas of project management,project processing and test strategies.

Each project group develops its own company model by means of customizing. The work is deemed tobe successful if the modeled business processes can be carried out using the implemented companymodel. For this purpose, it is also necessary for the groups to create project documentation that adheres to professional standards.

Forms of media:

Lectures with practical workshop sequences on the subjects of process modeling and processing.Introduction to the use of standard systems through basic scenarios.

Comprehensive project work organized by the students themselves, in groups of 4 to 5, covering the areas of customizing, project processing, documentation and test strategies. Students receive lecturenotes in electronic format.

Literature:

- Andre Maassen et.al. (2003): Grundkurs SAP R/3, Vieweg Verlag, 2nd edition
- SAP help system (online library)
- Michael Wobbermin (2000): Arbeitsbuch Buchhaltung, Jahresabschluß, Bilanzanalyse, Schäffer-Poeschel Verlag

Module:	Software Engineering	
Code:	wiB33	
Subtitle:		
Course elements:	Lectures with integrated practical sessions	
Semester:	Every semester	
Module coordinator:	Prof. Dr. Christian Decker	
Lecturer:	Prof. Dr. Christian Decker	
Language:	English	
Allocation to the curriculum:	Compulsory subject, 3rd semester	
Mode of teaching/semester hours per week (SWS):	Lecture	4 SWS
Total hours:	Contact time Independent study	60 hours 90 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisites:	None	
Mode of assesment:	Lectures: Written examination, presentation	

Module objectives:

Software processes
- Fundamental knowledge of software processes and procedural models
- Knowledge of when acquired procedural models can be used
- Knowledge of fundamental process activities

Agile software development
- Comprehension of the management problem of software development
- Fundamental knowledge for later practice
- Knowledge of agile SW development with the example of XP

Requirements Engineering
- Knowledge of terms and elements of requirement recording
- Ability to display and formulate requirements systematically

System modeling
- Ability to describe the structure and behavior of SW systems in a schematic manner
  □ using UMLAbility to perform a systems analysis.

Software draft with patterns
- Knowledge of a systematic approach to being able to describe system drafts
- Testing of ability to comprehend existing experience for drafts and to use if successfully
- Comprehension of testing as part of SW QA
- Knowledge of different testing methods and ability to explain the suitability and purpose

Fundamentals of project management
- Knowledge of basic terms, the methods and systematic procedure of management of SWprojects

Use of tools
- Ability to plan and track projects using MS Project
- Selected practices: Research, estimation, application
- Ability to research and evaluate different practices of project management and use them as an example

Learning outcomes:

Knowledge:

- Knowledge of products, methods, standards, processes and instruments designed for forward- thinking software engineering, creation of software-intensive products and software project management
- Knowledge of software process models, software design and fundamental workflows and roles in software engineering
- Knowledge of fundamental issues in project management
- Identification of requirements and formulation of specifications
- Systematic categorization and application of subject areas within software engineering and software project management.
- Knowledge of the modeling, validation and testing of software systems

Skills:

Students are able to take a systematic approach to categorizing and applying concepts, processes and methods. Using various projects, the students learn how to apply theoretical concepts and methods practically when working in project teams. They can work independently

on topics in the field of software engineering and project management and apply them in conjunction with the imparted knowledge. In various subject areas, they learn practical work with tools and methods.

Competencies:

Learning outcome (LO)	Assessed through
Are able to manage software projects in a planned and also agile manner and to select suitable methods according to the business environment and practical situation, in tandem with the business targets and can explain their choices.	Written examination
Ability to research and evaluate different practices of software engineering and project management independently and use them as an example. They employ learned instruments and/or tools and create a distinction to alternatives.	Presentation

Content:

Software represents an ever greater factor for the added value of products. The number of software- intensive products will continue to increase. The targeted, engineering development of software products and the management of software projects are the contents of this lecture. The following subject areas are addressed:

Software processes
- Various software processes, particularly waterfall, incremental development and others
- Discussion of advantages and disadvantages
- Change management: Tolerance to changes and avoidance of changes

Agile software development
- Derivation and inclusion of agile SW development
- Principles of Extreme Programming (XP)

Requirements Engineering
- Motivation, reasons for the failure of SW projects
- Basic terms: System specification, specifications, requirement types
- Recording of the requirements with Use Case diagrams

System modeling
- Inclusion in SW engineering
- UML diagrams: Use case, sequence, state, class diagram Introduction to OOA/D

Software draft with patterns
- Architecture patterns, e.g. MVC, MVP
- Design pattern: Singleton, observer, decorator
- Object-oriented interface draft: Interface vs. Multi inheritance

Testing
- Dynamic testing: Testing types and testing methods, e.g. Blackbox, Whitebox
- Test-driven development
- Static testing: User tests

Fundamentals of project management
- Stakeholders, project organization, procedural model, roles and responsibilities
- Specifications, initial project description, project order, project charter, scope statement
- Project report, milestone diagram, Quality Management Report
- Change Request management, sample Change

RequestsUse of tools
- Project planning with MS Project

Selected practices: Research, estimation, application, etc. with the following subtopics
- Requirements management
- Earned Value Analysis
- Business Case
- Target conflict matrix

Risk graph, ALARP
- Six Sigma
- V model http://www.vmodellxt.de/
- Agile software development / Scrum

Forms of media:

PDF of the slides from the lecture. Additional material to be announced during the lecture.

Literature:

- Ian Sommerville. *Software Engineering* (9th updated edition). Pearson, Deutschland, ISBN: 978-3-8632-6512-0

Module:	Web Programming
Code:	
Subtitle:	
Course elements:	Lectures and practical sessions
Semester:	Every semester
Module coordinator:	Prof. Dr. Martin Schmollinger
Lecturer:	Prof. Dr. Martin Schmollinger
Language:	English
Allocation to the curriculum:	Compulsory subject, 2rd semester
Mode of teaching/semester hours per week (SWS):	Lectures 2 SWS Practical session 2 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequistes:	Principles of informatics, advanced programming
Mode of assessment:	Lectures: Written examination, practical sessions

Module objectives:

This module aims to introduce students to the technology, structure and programming associated with web applications. It requires students to have acquired the competencies taught in the Principles of Informatics module. The majority of applications employed by companies are web-based. The competencies that are taught in this module are essential in understanding the functions of these applications, and are therefore a crucial part of an IT specialist's career. The modules entitled Databases, Networks, Systems and Security, and Distributed Systems build on aspects of this module.

Learning outcomes:

Knowledge:

- Knowledge of web application architectures.
- Ability to name basic technologies and describe how they relate to one another.
- Fundamental knowledge of programming languages and databases for implementing webapplications.
- Tools for developing web applications, and ability to understand and apply protection measuresfor them.
- Ability to name risks associated with web applications, as well as explain and apply appropriatecountermeasures.

Skills:

Students are able to develop their own web applications using basic technology. To do this, they use standard programming platforms, tools and systems. The focus where clients are concerned is on HTML/CSS and JavaScript. Programming on the server side is conducted using current frameworks such as PHP, Java or Node.js (JavaScript). Students are able to apply basic web application technologyand various approaches to web programming, with a database incorporated, and are able to put protection measures in place

Competencies:

This module helps students attain the technology skills they require and strengthens their knowledge of programming technology and software architectures. After completing this module, students will befamiliar with web application architecture and will be able to design an environment of this nature. Theywill be familiar with the web technologies associated with various architectural layers and will be able to use these for application development purposes, with the assistance of selected tools. They will alsobe aware of security issues relating to web applications.

LO#	Learning outcome (LO)	Assessed through
LO1	Confidently explain, present and discuss web applicationarchitectures.	Written examination/practical work
LO2	Be able to employ the web technologies associated withvarious architectural layers.	Written examination/practical work

LO3	Be able to develop web applications using the latest programming tools.	Written examination/practical work
LO4	Assess web applications with respect to security issues.	Written examination/practical work

Content:

This module teaches students about the fundamental technologies associated with web applications. It addresses basic types of technology as well as selected methods of web application programming onthe client and server sides (e.g. JavaScript, Java, PHP). As well as this, it presents selected principles that are used to provide protection for web applications

Forms of media:

The module consists of lectures in a seminar format, which include writing on the board, overhead projection and PC-based projection, plus practical sessions that apply the content of the lectures. Practical work is conducted using the latest software development tools. The course material is providedin electronic format.

- Lecture notes exercise sheets with tasks.

Literature:

- Ackermann, Philip (2016). JavaScript: Das umfassende Handbuch für Einsteiger,Fortgeschrittene und Profis. Rheinwerk Computing.
- Balzert, Heide (2017): Basiswissen Web-Programmierung. 2nd edition, Springer Campus.
- Theis, Thomas (2016): Einstieg in PHP 7 und MySQL. Rheinwerk Computing.
- Zeigermann, Oliver (2015) JavaScript für Java-Entwickler, 3rd edition, Entwickler.press

Module:	Corporate Finance	
Code:	wiB52	
Subtitle:		
Course elements:	Lectures	
Semester:	Every semester	
Module coordinator:	Prof. Dr. Josef Schürle	
Lecturer:	Prof. Dr. Josef Schürle	
Language:	English	
Allocation to the curriculum:	Compulsory subject, 3 th semester	
Mode of teaching/semester hours per week (SWS):	Lecture	4 SWS
Total hours:	Contact time Independent study	60 hours 90 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisites:	Basic principles of business and management economics, company accounting	
Mode of assessment:	Practical sessions, Wirtten examination	

Module objectives:

This module aims to provide students with more advanced knowledge of business administration. This means that students should be able to evaluate economic topics from a financial perspective and to make investment decisions from a risk / return point of view. In addition, students should understand the basic problems of financing and should know specific financing types as solution options.

Learning outcomes:

Knowledge:

The students have mastered the basics of financial mathematics and can apply them to investment decisions under security and risk. They understand the characteristics of a financially optimal investment decision. The students know the basic problems of financing and possess a structured overview of concrete types of financing.

Skills:

The students apply methods of business and financial economics to concrete investment decisions andderive financially-grounded decision suggestions from them. They plan liquidity developments with complete financial plans and close financial loopholes using suitable financing instruments.

Competencies:

The students are able to evaluate investment alternatives in a structured manner on the basis offinancial considerations and to derive decision-making suggestions from that. They possesses a well-founded economic evaluation competence and also include risk aspects in evaluation questions. When solving financing problems, the students are able to evaluate the concrete framework conditions in a well-founded manner and to select a suitable alternative from a broad financing spectrum.

Content:

- Basic principles of financial mathematics (interest, pension and repayment calculation)
- Investment decisions under security (static / dynamic method, complete financial plan, capitalvalue method, flat and non-flat interest rate curves)
- Investment decisions under insecurity (decision subject to risk, portfolio theory, CAPM, capitalcosts, application for corporate evaluation)
- Empirical analysis through application of the methods on available data from the company withclassical and digital business models
- Basic principles of financing (basic problem of financing, internal / external financing, proprietary
  / third-party financing, systematic overview of financing types)

Forms of media:

Imparting of the theoretical basic principles using beamer presentation, supplemented by texts on board. Discussion of solutions to the exercises. Web research on the financial data of the companies and analysis of the corporate data as group work.

Literature:

- Becker (2015): Investition und Finanzierung: Grundlagen der betrieblichen Finanzwirtschaft. 7th edition. Wiesbaden: SpringerGabler.
- Drukarczyk / Lobe (2014): Finanzierung. 11. edition. Konstanz: UVK.
- Kruschwitz / Husmann (2012): Finanzierung und Investition. 7th edition. Berlin: De Gruyter.
- Kruschwitz (2010): Finanzmathematik. 5th edition. Berlin: De Gruyter.
- Kruschwitz (2014): Investitionsrechnung. 14. edition. Berlin: De Gruyter.
- Perridon / Steiner / Rathgeber (2016): Finanzwirtschaft der Unternehmung. 17. edition. Munich: Vahlen.
- Wöhe / Bilstein / Ernst / Häcker (2013): Grundzüge der Unternehmensfinanzierung. 11. edition. Munich: Vahlen

Module:	Business Consulting	
Code:	wiB53	
Subtitle:		
Course elements:	Lectures	
Semester:	Every semester	
Module coordinator:	Prof. Dr. Dennis Schlegel	
Lecturer:	Prof. Dr. Dennis Schlegel	
Language:	English	
Allocation to the curriculum:	Compulsory subject, 5 th semester	
Mode of teaching/semester hours per week (SWS):	Lectures	4 SWS
Total hours:	Contact time Independent study	60 hours 90 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisites:	Knowledge oft he English language to level B2	
Mode of assessment:	Lectures: Written examination	

Module objectives:

The participants obtain the necessary qualification to apply basic consulting methods in business situations. The attained qualification permits the participants to make a contribution in everyday business work to the solution of financial practical problems, as well as at the interface between thespecialist area and IT.

Learning outcomes:

Knowledge:

The students are aware of fundamental consulting methods and can classify them in a corporate context.In particular, they are aware of the standard methods of Business Process Management and project management and can evaluate the advantages and disadvantages of different concepts.

Skills:

The students are able to plan and execute consultancy tasks through a methodical approach. They canstructure a project, plan data collection and prepare workshops.

Competencies:

The participants can apply the acquired specialist knowledge to concrete corporate problems. They can assume a mediator role between the specialist area and IT and compile possible solutions in a structuredmanner. They are able to hold structured interviews and to moderate workshops.

LO#	Learning outcome (LO)	Assessed through
LO1	Knowledge of basic consultancy methods	Written examination
LO2	Ability to plan methodically and carry out consultancy tasks	Written examination
LO3	Ability to apply the learned methods to concrete problems	Written examination

Content:

- Introduction to business consulting (e.g. consulting methods and industry)
- Strategy and performance management (e.g. strategy mapping and KPIs)
- Business process management (e.g. business background, process discovery, process analysis,process redesign)
- Project management (e.g. project organization, work breakdown structure, project timeline)

Forms of media:

Imparting of the basic theoretical and methodical principles through interactive lecture units, as well asjoint reading materials and discussion of English-language original sources (e.g. periodical articles).
Independent tackling of exercises and case studies in groups or individual work within contact time.

Literature:

- Andler: Tools for Project Management, Workshops and Consulting. Publicis
- Dumas, La Rosa, Mendling and Reijers: Fundamentals of Business Process Management.Springer International Publishing
- Kaplan and Norton: How Strategy Maps Frame an Organization‘s Objectives, in: *FinancialExecutive*, Mar/Apr 2004, Vol. 20 Issue 2, pp.40-45.
- Kubr: Management Consulting. A Guide to the Profession. Geneva: International Labour Office
- Milani: Digital Business Analysis. Springer International Publishing

Module: Entrepreneurship

Code:	wiB55
Subtitle:	
Course elements:	Lectures
Semester:	Every semester
Module coordinator:	Prof. Dr. Jürgen Münch
Lecturer:	Prof. Dr. Jürgen Münch
Language:	English
Allocation to the curriculum:	Compulsory subject, 5 th semester
Mode of teaching/semester hours per week (SWS):	Lecture 4 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	None
Mode of assessment:	Lectures: Project work

Module objectives:

The "Entrepreneurship" module provides you with key principles, methods and knowledge of intra- and entrepreneurship and allows you to act in an entrepreneurial way when founding a startup and when participating in innovative organizations. You will obtain a comprehensive insight in key topics for entrepreneurs, such as the development and implementation of a product idea, the setup of an agile organization, the management of teams, the financing of startups and innovation projects, as well as the development, transformation and validation of business models. Here, technology-driven and software-based innovation and business ideas are in the foreground. Using a wealth of practical examples, knowledge and tools, you will discover how to implement technological possibilities and innovation potentials in sustainable business models.

Learning outcomes:

Knowledge:

The students know the key basic principles, methods and tools of innovation management and business modeling. They can determine and evaluate innovation potential. They can explain the steps required to turn innovation potential into sustainable, scalable business models. The students know the special characteristics of intrapreneurship and corporate entrepreneurship in organizations. The students are able to explain how to employ agile methods to deal with uncertainties and risks in a successful manner.

Skills:

The students are able to apply the knowledge obtained to concrete cases and questions. They can develop business models from ideas, can make estimations of the economic viability of business models, validation individual components of business models and can implement the solutions connected to the business models in a prototypical fashion. They can define strategies and roadmaps for the development of products and services. The students are able to plan innovation and foundationprocesses in an independent manner. On completion of the module, the students are sensitive to entrepreneurial thought processes and the particular requirements and general conditions of innovation projects.

Competencies:

The students can classify the acquired knowledge correctly, can explain interdependencies and can apply the acquired knowledge to their own or given innovation ideas in startups or established companies. The students can be present their own innovation ideas and their implementation in the form of pitches (e.g. succinct short presentations in front of potential investors).

Content:

- Techniques, methods, tools and organizational aspects of intra- and entrepreneurship
- Innovation and foundation processes
- Lean Startup and Running Lean
- Problem Solution Fit
- Generation of business ideas

- Business modeling
- Customer development, problem validation and interviews
- Traction modeling, financial planning
- Product Market Fit
- Identification of key assumptions and hypotheses
- Business model validation and experimentation
- Minimum Viable Products
- Ideation and prototyping
- Pricing
- Branding
- Strategies for entrepreneurs and innovators
- Storytelling and pitching
- Scaling and growth hacking
- Lean Analytics and innovation metrics
- Cohort analysis
- Expansion strategies
- Design sprints
- Financing
- Models of venture capital companies
- Foundation promotion
- Capital procurement
- Corporate management and organization (e.g. with OKR, Lean Enterprise) Practical casestudies

Forms of media:

- Lectures plus accompanying practical sessions
- Work on case studies and tasks in teams
- Lecture material in electronic form

Literature:

- Marya, A. (2012): Running Lean: Iterate from Plan A to a Plan That Works. 2nd edition, O'Reilly.
- Maurya, A. (2016): Scaling Lean: Mastering the Key Metrics for Startup Growth. Portfolio.
- Osterwalder, A., & Pigneur, Y. (2010): Business model canvas. John Wiley & Sons.
- Osterwalder, A., Pigneur, Y., Bernarda, G., Smith, A. (2015): Value Proposition Design: How to Create Products and Services Customers Want. John Wiley & Sons.
- Ries, E. (2011): The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses. Crown Books.
- Ries, E. (2017): The Startup Way: How Entrepreneurial Management Transforms Culture and Drives Growth. Portfolio Penguin.
- Viki, T. und Toma, D. (2017): The Corporate Startup: How Established Companies Can Develop Successful Innovation Ecosystems. Vakmedianet Management bv.

Module:	Management and Controlling
Code:	wiB52
Subtitle:	
Course elements:	Lectures
Semester:	Every semester
Module coordinator:	Prof. Armin Roth
Lecturer:	Prof. Armin Roth
Language:	English
Allocation to the curriculum:	Compulsory subject, 3 th semester
Mode of teaching/semester hours per week (SWS):	Lectures 4 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	Basic principles of business and management economics, company accounting
Mode of assessment:	Lectures: Presentation, private study projects

Module objectives:

This module presents and discusses the entire management process. It examines the "lifecycle" of a company from a managerial perspective, from the initial idea for the business to selling the company. The aim of the module is to heighten students' awareness of business concerns and teach them aboutthe tasks involved in controlling and management, as well as the methods used to approach this.

Learning outcomes:

Knowledge:

- Be familiar with and able to name the instruments, methods and processes used in company management.
- Be able to name and use strategic methods in management and controlling
- Be familiar with organizational rules
- Be familiar with the principles of corporate cultures
- Be able to describe change management
- Be familiar with and able to apply human resources management techniques
- Be able to describe and explain the basics of management models, management information systems and information management
- Be aware of and able to use key figure systems and reporting systems for performancemeasurement in the context concerned.

Skills:

Students have a clearer vision of the entire "lifecycle" of a company from a management and controllingperspective, from the initial idea for the business to selling the company.
Knowledge of processes and instruments involved in strategic and operational management is acquired by means of examples. Leadership models are created. Insights into human resources management foster students' abilities to deploy staff effectively.

Competencies:

Students assess the action parameters involved in management and discuss the various methods thatcan be used in management from the perspective of how well suited they are to practical application. They are able to reflect on this. Students are able to discuss the subject matter from a practical, managerial perspective and with a specific focus in mind.

LO#	Learning outcome (LO)	Assessed through
LO1	Understand and be able to describe management andcontrolling processes	Presentation; case study work, privatestudy projects
LO2	Be familiar with and able to assess management actionparameters	Presentation; case study work, privatestudy projects
LO3	Be able to describe and apply various management methods and controlling tools	Presentation; Case study work Private study projects

Content:

The management process (planning, organization, staff deployment, leadership and controlling) is usedas a basis for considering each of the process steps and the latest tools and methods associated withthem. Specifically, the following subject areas are addressed:

- Principles of company management
- Strategic management and controlling: Processes and tools
- Operational management and controlling: Processes and tools
- Organization
- Corporate culture
- Change management
- Human resources management
- Reporting/key figures systems involved in performance measurement
- Management information systems and information management
- Leadership/leadership models

Forms of media:

Lectures, work in small groups, case studies, presentation and written work, simulation game.

Literature:

- Staehle, W.: Management, Vahlen, latest edition.
- Steinmann, H.; Schreyögg, G.: Management, latest edition
- Horváth, P.: Controlling, latest edition
- Reichmann, T.: Controlling mit Kennzahlen und Managementberichten, latest edition, Munich.
- Roth, A.; Behme, W. (1997): Organisation und Steuerung von dezentralenUnternehmenseinheiten, Wiesbaden: Gabler.
- Roth, A. (2014): Ganzheitliches Performance Management, Munich: Haufe.
- Roth, A. (2016): Einführung und Umsetzung von Industrie 4.0, Heidelberg/Berlin: Springer.
- Schweitzer, M.; Küpper H.-U.: Systeme der Kosten- und Erlösrechnung, latest edition, Munich
- Weber, J.: Einführung in das Controlling, latest edition, Stuttgart
- Case study-related literature

Module:	Distributed Systems
Code:	wiB56
Subtitle:	Foundations for Programming Enterprise Applications
Course elements:	Lectures and Hands- on Training
Semester:	Every semester
Module coordinator:	Prof. Dr. Martin Schmollinger
Lecturer:	Prof. Dr. Martin Schmollinger
Language:	English
Allocation to the curriculum:	Compulsory subject, 5 th semester, bachelor program „Business Informatics“
Mode of teaching/semester hours per week (SWS):	Lectures 2 SWS Practical sessions 2 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	Computer Science modules of the bachelor program “Business Informatics” (semester 1-4). Especially advanced skills in Java programming.
Mode of assessment:	Written test and successful participation atpractical sessions.

Module objectives:

Today, modern enterprise applications are developed as distributed systems for the cloud. In the module, the basic knowledge, skills and competencies are conveyed to be a door opener to students tothe area of enterprise application programming.

Learning outcomes:

Knowledge:

Students understand the collaboration of applications or parts of applications in distributed environments.

Especially, they are aware of challenges that arise in distributed environments in contrast to non-distributed environments (“Fallacies of distributed computing”). They know different approaches to program and implement distributed systems and applications.

Skills:

Students are able to understand and estimate requirements and properties of existing or new distributed applications or systems. They know common implementation choices to adapt or createsuch applications or systems, and are capable to select and apply to them. Particularly, students learn current approaches to implement distributed applications. This skill isdeepened by programming exercises using a current programming language, appropriate frameworks and tools. Hence, students use the Java programming language (advanced knowledge is a prerequisite!), the Spring Boot framework, the build tool gradle and Visual Studio Code as IDE. Further, Docker is used as a precondition for the deployment to the cloud.

Competencies:

The higher-order learning objectives are to understand, design, develop and deploy complex applications in distributed environments. Particularly, students receive implementation and method competencies to reach these objectives. The achievement rate of these competencies will betested by a written examination at the end of the semester and by reviewing their solutions to exercises in the practical sessions.

Content:

- Definitions and Terminology
- Processes and Threads
    - Threads in non-distributed systems
    - Thread implementations
    - Threads in distributed systems
- Java Threads
- Architecture Styles
- Spring Boot
- Microservices
- Communication Styles
    - From In-Process to Inter-Process Communication
    - Collaboration Style and Common Implementation Choices
- Foundations of the deployment of distributed applications to Cloud environments

Forms of media:

Lecture:

- Lecture about module content based on slides.

Practical Sessions:

- Develop solutions to programming exercises provided by a training booklet.
- Solutions are provided later on a Git server.
- Video clips explaining the installation and usage of programming tools.

Literature:

- van Steen, Tanenbaum: Distributed Systems, Published by Martin van Steen (previouslypublished by Prentice Hall) (2017
- Newman, Building Microservices, O'Reilly (2015/2021)
- Heckler, Spring Boot Up & Running, O'Reilly (2021)
- Friesen, Java Threads and the Concurrency Utilities, APress (2015)
- Gonzales, Mastering Concurrency Programming with Java 9, Packt Publishing (2017)
- Bullington-McGuire et al., Docker for Developers, Packt (2020).

Module:	Sustainability Management	
Course elements:	Lectures	
Semester:	Every Semester	
Language:	English	
Mode of teaching/semester hours per week (SWS):	Lecture	4 SWS
Total hours:	Presence Self directed	60 hours 90 hours
Credits:	5 ECTS	
Mode of assessment:	Presentation, Continuous Assessment	

Module objectives:

This course provides an introduction to sustainability management, the role of information technology in supporting corporate sustainability practices, and the growing importance of environmental, social, and governance (ESG) reporting for businesses. Students will learn about key sustainability challenges and opportunities, sustainable business models, ESG reporting frameworks, and the latest technological developments and innovations in the field of sustainability management. Students will understand how information technology can support sustainability management practices in a variety of areas, from data management to business model-specific applications to reporting.

Learning outcomes:

Knowledge:

- Students will know the definition and principles of sustainability and sustainability management.
- They will be able to explain the business case for sustainability and relate it to the UN Sustainable Development Goals (SDGs)
- Students will understand the key challenges and opportunities of sustainability for businesses
- Students are familiar with sustainable business models and practices. They are familiar with the principles of circular economy and sustainable supply chain management.
- You can evaluate various ESG reporting frameworks and requirements and are familiar with their implementation in information systems
- Have knowledge of current technological developments and innovations in sustainability management, such as smart energy systems, intelligent transportation systems, and sustainable finance

Skills:

- Definition and principles of sustainability and sustainability management
- The business case for sustainability
- The role of public policy and regulation in sustainability management
- The UN Sustainable Development Goals (SDGs) and how companies can contribute to them
- Stakeholder engagement and corporate social responsibility (CSR)
- Circular economy principles and practices
- ESG reporting & metrics systems
- Life cycle assessment and sustainability metrics
- Challenges in practice: sustainability reporting and data management
- Use cases and IT systems: environmental management systems, energy management, building design, transportation, etc.

Competencies:

- Students are able to classify their acquired knowledge in a professional manner, to explain correlations and to apply them in professional practice. In doing so, the lecture lays the foundations for an activity in the environment of sustainability management or in the development of IT systems to meet sustainability requirements.
- Students are able to familiarize themselves with new areas of sustainability in general and deal with the requirements of new ESG standards in particular.
- In addition, the students have models and frameworks to analyze sustainability issues in the company and to develop solutions.
- They are able to take on leadership roles in sustainability issues and to communicate the relevance and consequences of sustainability-oriented corporate management to stakeholders.

Contents

- Definition and principles of sustainability and sustainability management
- The business case for sustainability
- The role of public policy and regulation in sustainability management
- The UN Sustainable Development Goals (SDGs) and how companies can contribute to them
- Stakeholder engagement and corporate social responsibility (CSR)
- Circular economy principles and practices
- ESG reporting & metrics systems
- Life cycle assessment and sustainability metrics
- Challenges in practice: sustainability reporting and data management
- Use cases and IT systems: environmental management systems, energy management, building design, transportation, etc.

Media forms

Lecture, exercises and case studies

Literature

- Combe, C. (2022). Introduction to global sustainable management. SAGE.
- GRI Standards: https://www.globalreporting.org/how-to-use-the-gri-standards/gri-standards-english-language/
- Further readings will be announced during the lecture

Module:	Internetworking	
Code:	mkiB35	
Subtitle:	Networks and Protocols	
Course elements:	Lectures	
Semester:	Every semester	
Module coordinator:	Prof. Marcus Schöller	
Lecturer:	Prof. Marcus Schöller	
Language:	German, English	
Allocation to the curriculum:	**C**ompulsory subject, 3rd semester	
Mode of teaching/semester hours per week (SWS):	Lecture	4 SWS
Total hours:	Contact time Independent study	60 hours 90 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisites:	None	
Mode of assessment:	Lectures: Written examination Practical sessions	

Module objectives:

This module equips students with knowledge about the Internet's infrastructure and communication protocols. Students have already gained an initial insight into programming web applications in the Informatics 2 module. This is used as a basis for discussing the main Internet protocols on all layers and classifying them within the ISO/OSI reference model. At the same time, students are introduced to the hardware that is used in this context, all the way through to Ethernet wiring.
This module lays the foundations for subsequent modules, including Distributed Systems and IT Security in the 4th semester of the degree programme, as well as Mobile Computing and Cloud Computing in the 6th semester.

Learning outcomes:

Knowledge:

- Be able to name the layers and tasks of the ISO/OSI reference model, as well as the TCP/IP model.
- Be able to name typical Internet protocols (such as HTTP, FTP, SMTP, SNTP, DNS, TCP, UDP, IP, ICMP, DHCP, ARP, CSMA/CD, CSMA/CA, TDMA, Ethernet and WLAN), be able to describe their functions and protocol headers, and be able to categorise protocols into the reference model layers.
- Be able to explain the stop-and-wait algorithm and the sliding window algorithm.
- Be able to describe overload control methods in TCP.
- Be familiar with various types of framing (byte count method, sentinel method).
- Be able to name and describe basic terminology and processes associated with error detection (Hamming distance, parities, CRC).
- Be able to reproduce modulation types and typical coding methods (such as NRZ, NRZI and Manchester).
- Be familiar with performance parameters for networks.
- Be able to name typical transfer modes, network topologies and their properties. Be able to specify the hardware involved in an Internet infrastructure (such as routers, switches and hubs) and describe how it works.
- Be able to explain the hidden node problem and potential solutions (MACA and MACAW).

Skills:

- Be able to structure communication in multi-tier architectures, from the database server, to the application and web server, all the way through to the client.
- Be able to structure home and intranet computer connections to the Internet.
- Be able to program socket connections and simple client-server applications in Java.
- Be able to calculate examples of distance vector routing, link state routing and the spanning tree algorithm on the basis of a graph.
- Be able to outline routing between various subnets and calculate Ethernet subnetwork masks.
- Be able to log and evaluate Internet communication using a sniffer.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Analyse known and new protocols and network technology, and categorise them within the ISO/OSI and TCP/IP reference models. As a result, collect and interpret data packets. Understand the tasks of typical protocols at application level to such an extent that they are able to contextualise and evaluate the functions of other protocols. Design and evaluate simple infrastructures.	Written examination
LO2	Evaluate the applications to which TCP or UDP is better suited. Discuss the properties and algorithms associated with protocols, and implement their own small-scale applications using socket programming.	Written examination

LO3	Understand typical network layer protocols and their tasks, and evaluate the applications associated with them. Design and calculate subnetworks. Use routers and apply various routing protocols based on examples.	Written examination
LO4	Be familiar with and apply typical processes and parameters for enclosing the payload in frames. Discuss the meaning of framing and describe the hardware associated with it.	Written examination
LO5	Discuss the conversion of data (frames) into electronic signals and vice versa, and discuss commonly used transfer modes and network topologies, plus the properties and problems associated with them.	Written examination

Content:

This module picks up at the point where students left off in Informatics 2 and Informatics 3, in which they gained their first experience of programming web applications. Starting from the application layer and working all the way through to management level, it presents and analyses typical Internet protocols, algorithms, processes and hardware.
The first stage involves presenting the TCP/IP and ISO/OSI reference model [Stein 2004] as well as typical application layer protocols, such as HTTP, FTP, SMTP, SNTP and DNS [Kurose, Ross 2012]. In this context, students are shown the Wireshark sniffing software [Wireshark 2013] and intercept their first examples of HTTP and FTP data between a server and a client. With the students' participation, typical network structures such as 3-tier and 4-tierarchitectures are developed and a typical home network with DSL and WLAN routers is structured (LO1).
Students are then shown the TCP and UDP protocols, plus the differences between them. In this context, the module explains the three-way handshake, stop-and-wait transmission, and the sliding window algorithm, as well as TCP overload control [Tanenbaum 2003]. Socket programming is presented in Java in order to demonstrate practical applications [Calvert, Donahoo 2008] (LO2).
On the next-lowest protocol layer, the module presents IP, ICMP, DHCP and ARP, and analyses them using Wireshark. This involves a description of routers as hardware, the formation of subnetworks, plus distance vector routing, link state routing and the spanning tree algorithm as routing methods [Tanenbaum 2003] (LO3).
The module also looks at Ethernet frames, types of framing as well as basic error detection terminology and methods on the bit transmission layer, the data link layer and the Ethernet layer [Tanenbaum 2003]. It presents switches and hubs as types of hardware that can be used in this context, and demonstrates how they work [Kurose, Ross 2012] (LO4).
Where transmitting data between various devices is concerned, the module discusses the main transmission methods and network topologies, along with their properties and basic modulation and coding methods [Stein 2004]. Additionally, performance parameters are defined for networks and calculated using typical examples [Tanenbaum 2003]. Finally, the module takes a brief look at wireless transmission using WLAN, the standards associated with this, and the hidden node problem plus its potential solutions [Tanenbaum 2003] (LO5).

Forms of media:

- Teaching in seminar format with PC-based projection and slides, plus demonstration of analysing data sent via a network. The slides are made available to download at the start of the module.
- Information is written on the board to help students gain an understandingof communication via a network.

Literature:

- Calvert, Kenneth L.; Donahoo, Michael J. (2008): TCPIP sockets in Java. Practical guide for programmers. 2nd ed. Amsterdam, Heidelberg: Morgan Kaufmann (The Morgan Kaufmann Practical Guides Series).
- Kurose, James F.; Ross, Keith W. (2012): Computernetzwerke. Der Top-Down-Ansatz. 5th edition, updated. Munich: Pearson (Always Learning).
- Peterson, Larry L.; Davie, Bruce S. (2000): Computernetze. Ein modernes Lehrbuch. 1st edition. Heidelberg: Dpunkt-Verl.
- Tanenbaum, Andrew S. (2003): Computernetzwerke. 4th edition, revised. Munich: Pearson (Pearson Studium).
- Stein, Erich (2004): Taschenbuch Rechnernetze und Internet. Mit … 105 Tabellen. 2nd edition, revised. Munich: Fachbuchverlag Leipzig.
- WireShark Network Sniffer: <http://www.wireshark.org/>

Module:	Database Systems 2
Code:	mkiB41
Subtitle:	
Course elements:	Lectures
Semester:	Only fall
Module coordinator:	Prof. Peter Hertkorn
Lecturer:	Prof. Peter Hertkorn
Language:	German
Allocation to the curriculum:	Compulsorysubject, 4th semester
Mode of teaching/semester hours per week (SWS):	Lectures 4 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	None
Mode of assessment:	Lectures: Written examination

Module objectives:

Students acquire knowledge of how database systems and various database technologies work. They understand the underlying principles, methods and techniques, and are able to put the theoretical knowledge they have learned into practice. Passing this module should ensure that, as students continue in their studies, they are able to design a database using a systematic approach, weigh up modelling decisions, as well as construct and use databases with the assistance of database and programming languages.

Learning outcomes:

Knowledge:

- Be able to explain the tasks and goals associated with a database system.
- Be able to demonstrate the architecture of database systems.
- Be able to describe the stages in designing a database.
- Be familiar with various data models and be able to explain the differences between them.

- Be familiar with methods of modelling real-world contexts.
- Be familiar with methods of mapping a semantic data model to a relational model.
- Be able to explain the causes of data anomalies and be familiar with techniques for preventing them.
- Be familiar with the concepts and elements of database languages.
- Be able to explain the basic properties of transactions.
- Be able to illustrate problems caused by concurrency and be familiar with techniques for avoiding them.
- Be familiar with methods of accessing a database from an application program.
- Be able to explain the properties of object-relational databases.
- Be familiar with methods of storing semi-structured data.
- Be able to describe the concepts underpinning more recent developments, such as NoSQL databases, and explain how they differ from relational database systems.

Skills:

Students analyse the requirements for a specific problem and create a semantic data model on this basis. They derive a relational model from the semantic data model. Students are able to assess the quality of the relational model and apply techniques for preventing data anomalies. They create and modify relational database schemas using database languages, and formulate queries for databases as well as modifications to databases. They apply various methods of managing concurrent transactions. They create database schemas and queries for object-relational databases, as well as queries for semi-structured data on the basis of XML extensions to the relational model.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Apply various methods for the systematic design of databases.	Written examination
LO2	Evaluate modelling alternatives when creating databases.	Written examination
LO3	Create databases for various data models using database languages.	Written examination
LO4	Formulate database queries for specific requirements.	Written examination
LO5	Evaluate alternative options for database queries and assess them with regard to performance.	Written examination
LO6	Analyse transactions with regard to concurrency problems and apply suitable methods of multi-user synchronisation.	Written examination
LO7	Evaluate and grasp current developments in database systems.	Written examination

Content:

The lectures in this module introduce students to this subject by explaining how database systems are used, and explaining the basic architecture model that underpins them.
It systematically works through the individual stages of designing a database on the basis of a case study (LO1). The entity relationship model is used for semantic data modelling purposes (LO1, LO2). The module deals with the theory and the practical design rules associated with the relational model (LO1, LO2). The data manipulation and definition

language SQL is used to create database schemas and develop database queries (LO3–5). Transaction concepts and synchronisation mechanisms are explored in order to help students understand database functions (LO6). In addition to classic relational databases, the module considers object-relational databases and XML extensions for the relational model (LO3, LO4). It also compares more recent developments – such as NoSQL databases – and their properties with those of relational database systems (LO7). It shows students how to access databases from within an application, using examples of programs to explain this.

Forms of media:

The teaching material consists of slide notes presented in electronic format, exercise sheets and examples of programs. Teaching in seminar format with information written on the board, PC-based projection and presentation slides with illustrative examples of theoretical content, plus demonstration of example programs and interactive program development.

Literature:

- Beaulieu, Alan (2009): Learning SQL. 2nd ed (online). Sebastopol: O'Reilly Media (EBL-Schweitzer).
- Connolly, Thomas (2015): Database Systems: A Practical Approach to Design. 6th edition. Harlow: Pearson Education Limited.
- Date, Chris J. (2004): An introduction to database systems. 8th ed., internat. ed. Boston, München: Pearson Addison Wesley.
- Elmasri, Ramez; Navathe, Sham (2010): Fundamentals of database systems. 6th ed. Upper Saddle River, N.J., Harlow: Pearson Education.
- Garcia-Molina, Hector; Ullman, Jeffrey D.; Widom, Jennifer (2009): Database systems. The complete book. 2nd ed., internat. ed. Upper Saddle River, NJ: Pearson Prentice Hall.
- Kemper, Alfons; Eickler, André (2013): Datenbanksysteme. Eine Einführung.9th edition, expanded and updated. Munich: Oldenbourg.
- Kemper, Alfons; Wimmer, Martin (2012): Übungsbuch Datenbanksysteme. 3rd edition, updated and expanded. Munich: Oldenbourg.
- Saake, Gunter; Sattler, Kai-Uwe; Heuer, Andreas (2013): Datenbanken. Konzepte und Sprachen. 5th edition. Heidelberg, Munich, Landsberg, Frechen, Hamburg: mitp.
- Sadalage, Pramod J.; Fowler, Martin (2012, c2013): NoSQL distilled. A brief guide to the emerging world of polyglot persistence. Upper Saddle River, NJ: Addison-Wesley. Available online at http://proquest.tech.safaribooksonline.de/9780133036138.
- Vonhoegen, Helmut (2013): Einstieg in XML. Grundlagen Praxis Referenz; [für Anwendungsentwicklung und E-Publishing; Transformation Formatierung; Schnittstellen; XML Schema DTD XSLT CSS XSL XPath DOM SAX SOAP XQuery; XForms HTML5 EPUB]. 7th edition, updated and expanded. Bonn: Galileo Press (Galileo Computing).
- Vossen, Gottfried (2008): Datenmodelle, Datenbanksprachen und Datenbankmanagementsysteme. 5th edition, revised and expanded. Munich, Vienna: Oldenbourg.

Module:	Distributed Systems	
Code:	mkiB44	
Subtitle:		
Course elements:	Lectures Practical sessions	
Semester:	Every semester	
Module coordinator:	Prof. Natividad Martinez	
Lecturer:	Prof. Natividad Martinez	
Language:	German, English	
Allocation to the curriculum:	Compulsory subject, 4th semester	
Mode of teaching/semester hours per week (SWS):	Lecture	4 SWS
Total hours:	Contact time Independent study	60 hours 90 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisites:	None	
Mode of assessment:	Lectures and practical sessions: Continuous assessment	

Module objectives:

Students acquire knowledge of systems and architectures for using distributed computer resources. They are able to program distributed applications and have knowledge of basic distributed algorithms. Additionally, they are aware of the advantages and disadvantages of technologies used for creating distributed applications, and are able to explain them. They are able to select an appropriate distributed technology for a given problem. There is a particular focus on web technologies. Students learn how to design and program web applications, and apply prototypes of them in a project.
This module combines a large number of skills and competencies that students have already learned in other modules: developing software, programming software, and using systemic aspects of operating systems, databases and internetworking to create an entire end-to-end system. It forms the basis for the later modules entitled Mobile Computing and Cloud Computing.

Learning outcomes:

Knowledge:

Students are familiar with the properties and structure of a distributed system. They are familiar with typical middleware architecture, the remote method invocation paradigm, and how to implement remote method invocations.
Students identify the properties of component-based distributed architectures based on examples of company-based distributed architectures.
Students are aware of the principle of service-oriented architecture (SOA) based on a web services example, and are able to classify it on the basis of REST architectures and SOAP-based web services.
Additionally, students are aware of the main technologies used for designing the client side and server side of a web application.

Skills:

Students model a distributed system and put it into operation using Java RMI middleware. To do this, they use basic communication mechanisms and patterns.
They divide a company web application into processes and entities in order to fulfil the specified requirements. They develop company web applications in a multi-layer architecture and incorporate straightforward methods of accessing databases into these.
They design web services and assess which type (REST or SOAP) is most suitable.
They apply conventional information display and web programming technologies. In doing so, they are able to identify aspects relating to security, data protection, efficiency and usability.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Analyse and evaluate various distributed architectures.	Written examination
LO2	Develop proposals for solutions to example scenarios based on the distributed technologies they have become familiar with.	Practical sessions
LO3	Design a complete web-based distributed system with certain requirements and basic conditions taken into account.	Project work
LO4	Work in a team in order to find solutions to complex tasks.	Project work
LO5	Use state-of-the-art development environments and tools.	Project work
LO6	Research and evaluate information about current developments in distributed systems, and communicate it on a scientific level.	Report
LO7	Capably present and discuss subject areas relating to the discipline of distributed systems, using specialist language.	Presentation

Content:

The Distributed Systems module combines many of the programming, software development and database-related skills that students have already acquired. The content is designed to cover an extremely wide scope and maintains a focus on applications. For this reason, a continuous assessment format has been chosen, allowing students' progress to be tracked using various artifacts. The module is divided into four areas. A theory-based introduction is provided for each area; a brief certification process is used to test students' understanding of this (LO1), together with exercises (LO2) that the students work through either alone or in groups. This is followed by practical laboratory tasks (LO5) that are carried outin groups and combined as a project (LO3, LO4). The second half of the module requires students to prepare an assignment on a current topic within the discipline (LO6) and present their findings (LO7). The subject areas are:

1. Principles and architectures of distributed systems; middleware for distributed systems and the Remote Method Invocation (RMI) [Coulouris].
2. Web programming: client-side versus server-side programming [Sebesta].
3. Service-oriented architectures and web services: properties and comparison of REST and SOAP architectures [Kalin].
4. Distributed, component-based platforms for company applications [Wetherbee].

Forms of media:

The forms of media differ according to the content and the competencies. Some subject areas use conventional slide notes that are projected and may then explained, illustrated and expanded upon using the board. Either individually or in groups, students work on and present topics in a seminar format, using selected reference sources. The module consistsof lectures plus accompanying practical sessions. Students receive information on the installation and system requirements, and must then develop system prototypes under the supervision of lecturers in the laboratory.

Literature:

- Coulouris, George F. (2012): Distributed systems. Concepts and design. 5th ed., internat. ed. Boston, Munich: Addison-Wesley.
- Kalin, Martin (2013): Java Web services. Up and running. 2nd ed. Beijing: O'Reilly. Online verfügbar unter http://proquest.tech.safaribooksonline.de/9781449373856.
- Sebesta, Robert W. (2013): Programming the World Wide Web. 7th ed. Boston: Pearson.
- Wetherbee, Jonathan (2013): Beginning EJB 3. Java EE 7th edition. [Berkeley, CA]: Apress. Available online at http://proquest.tech.safaribooksonline.de/9781430246923.
- Additionally, current articles from specialist journals and conferences as well as Internet resources.

Module:	Computer Graphics	
Code:	mkiB46	
Subtitle:		
Course elements:	Lectures Practical sessions	
Semester:	Every semester	
Module coordinator:	Prof. Uwe Kloos	
Lecturer:	Prof. Uwe Kloos	
Language:	German, English (if required)	
Allocation to the curriculum:	Compulsory subject, 4th semester	
Mode of teaching/semester hours per week (SWS):	Lecture	4 SWS
Total hours:	Contact time Independent study	60 hours 90 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisities:	None	
Mode of assessment:	Lectures: Written examination, practical sessions	

Module objective:

The aim of this module is to raise students' awareness of subjects relating to computer graphics, as well as enable them to develop and understand 3D graphics programs. Building on the media-related Graphics, Audio and Video modules and allowing students to use the skills they have acquired in these, this module examines computer-based 3D graphics processes. A pass in this module will ensure students can go on to develop graphics programs as well as understand and operate graphics applications in the next stage of their studies.

Learning outcomes:

Knowledge:

- Students are familiar with the mathematical basis for calculating transformations of three-dimensional objects as well as various vector operations.
- They are familiar with the graphics pipeline and the various methods used within this pipeline.
- They are able to name local and global lighting techniques and know the differencesbetween them.
- They are familiar with a range of texturing methods and are able to apply them to 3D objects.
- They are familiar with various modelling methods and are able to create complex 3D worlds on the basis of simple objects.
- They are able to name various methods of swapping objects in 3D worlds and are aware of the advantages and disadvantages of doing so.
- They know the difference between static images and dynamic animations, and are able to name and use various control mechanisms for generating an animation.

Skills:

Students calculate transformations independently, are able to evaluate the mathematical methods used in computer graphics, and are able to construct their own processes on this basis. Additionally, they are able to analyse a specific challenge in the area of computer graphics and evaluate existing algorithms in a way that allows them to select the methods which will produce an efficient solution. They also develop these solutions with performance taken into consideration, and are able to analyse and evaluate graphics applications with respect to this. As well as this, they are able to work with a standard graphics tool and create simple animations.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Manually calculate transformations of 3D objects in homogeneous coordinates and vector operations.	Written examination, artifact

LO2	Understand and implement a freely available graphics library.	Artifact
LO3	Apply acquired knowledge independently to a graphics application implementation.	Written examination, artifact
LO4	Analyse the processes used in graphics applications and evaluate their benefits and drawbacks.	Written examination
LO5	Use professional modelling and animation tools to create 3D models and animations.	Artifact
LO6	Assess problems and limitations arising from the development of graphics applications.	Artifact
LO7	Assess own developments and abilities.	Artifact
LO8	Evaluate and grasp current developments in computer graphics.	Artifact

Content:

This module introduces students to the subject of computer graphics and related areas (animation, visualisation). In each case, there is a theory component that examines and discusses selected topics in detail. This focuses on teaching standard algorithms and principles. This theoretical knowledge is then put into practice in small exercise units, and students develop their own graphics programs on the basis of a standardised graphics library. The module examines fundamental techniques and procedures, from model to image (transformations, projections, visibility testing, colouring and rasterisation). It also considers subject areas such as modelling, local and global lighting, and textures. During the practical stage, tools used in the industry are deployed so that students are given hands-on experience.

Forms of media:

The teaching material consists of slide notes distributed in electronic format and made available via a central server, plus an introduction to OpenGL. The module consistsof lectures plus accompanying practical sessions. Teaching is conducted in a seminar format, with theoretical content illustrated using multimedia examples. Either individuallyor in groups, students work through various exercises on the subject of computer graphics. Through practical exercises, the module starts by exploring the mathematical methods that form the basis of transformations. Following this, several exercise units gradually buildup a complex graphical application based on an open-source graphics library. Basic procedures for modelling and animation techniques are also discussed and implemented in a practical project. The practical stage ensures that tools used in the industry are applied. The lecturer supervises the programming exercises and the animation project.

Literature:

- Angel, Edward (2006): Interactive computer graphics. A top-down approach using OpenGL. 4th ed., internat. ed. Boston, Mass., Munich: Pearson Addison-Wesley.
- Bender, Michael; Brill, Manfred (2006): Computergrafik. Ein anwendungsorientiertes Lehrbuch. 2nd edition, updated. Munich, Vienna: Hanser.
- Nischwitz, Alfred; Haberäcker, Peter (2004): Masterkurs Computergrafik und Bildverarbeitung. Alles für Studium und Praxis; Bildverarbeitungswerkzeuge Beispiel-Software und interaktive Vorlesungen online verfügbar. 1st edition. Wiesbaden: Vieweg.
- Watt, Alan H. (2005): 3D computer graphics. 3rd ed. [repr.]. Harlow: Addison-Wesley.
- Students will be informed of other in-depth sources of literature during the course.

Module: Mobile Computing

Code:	mkiB62
Subtitle:	
Course elements:	Lectures Practical sessions
Semester:	Every semester
Module coordinator:	Prof. Natividad Martínez
Lecturer:	Prof. Natividad Martínez
Language:	German, English
Allocation to the curriculum:	Compulsory subject, 6th semester
Mode of teaching/semester hours per week (SWS):	Lectures 4 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	None
Mode of assessment:	Lectures: Continuous assessment

Module objectives:

Mobile Computing provides an introduction to the subject of distributed and mobile systems. The aim of this module is to familiarise students with the principles of mobile communication networks and enable them to use key pieces of technology when developing mobile applications. The module builds on knowledge that students have already learned on the subjects of web programming (in Distributed Systems) and computer networks(in Internetworking), and also relates to aspects of IT security.

Learning outcomes:

Knowledge:
Students acquire knowledge of the ways in which protocols for mobile applications work, on the basis of the Internet. They learn which requirements these applications impose and how they are met by protocols and services on lower levels.

Additionally, they acquire basic knowledge of mobile computing and learn about typical scenarios and tasks in the process. They are able to describe execution platforms and are familiar with supporting technology.
They are familiar with the principles underpinning the Internet of Things, and the main properties of sensors and sensor networks.

Skills:

Students apply the knowledge they have acquired on the subject of mobile applicationsto independent work in which they create solutions to exercises. They learn how to use hardware and software-based analysis tools, and how to track communication processes at protocol level.
They compare various mobile operating systems and execution platforms with regard to defined requirements. They program solutions to problems on typical platforms, such as smartphones, tablet PCs, embedded systems, and so on. Additionally, they plan the integration of sensors and sensor networks, and develop applications (which may be environment-dependent).

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Analyse and evaluate various mobile technologies.	Written examination
LO2	Develop proposals for solutions to example scenarios based on the mobile technologies they have become familiar with.	Practical sessions
LO3	Design a mobile application with certain requirements and basic conditions taken into account.	Project work
LO4	Work in a team in order to find solutions to complex tasks.	Project work
LO5	Use state-of-the-art development environments and tools.	Project work
LO6	Research and evaluate information about current developments in mobile computing, and communicate it on a scientific level.	Report
LO7	Capably present and discuss subject areas relating to the discipline of mobile computing, using specialist language.	Presentation

Content:

Mobile Computing is divided into three main areas: mobile communication, programming mobile applications, and the Internet of Things. The discussion of this content is designed to cover an extremely wide scope and maintains a focus on applications. For this reason, a continuous assessment format has been chosen, allowing students' progress to be tracked using various artifacts. A theory-based introduction is provided for each area; a certification process is used to test students' understanding of this (LO1), together with exercises (LO2) that the students work through either alone or in groups. This is followed by practical laboratory tasks (LO5) that are carried out in groups and combined as a project (LO3, LO4). The second half of the module requires students to prepare an assignment on a current topicwithin the discipline (LO6) and present their findings (LO7). The subject areas are:

1. Principles of mobile communication: wireless and mobile networks [Schiller].
2. Programming mobile applications: introduction to web app programming with HTML5 and native apps in Android, iOS, Windows Phone and QNX. Advanced programming in Android [Meier].
3. Introduction to the Internet of Things [Kalin] [Ewen].

Forms of media:

The forms of media differ according to the content and the competencies that are being developed in students. Some subject areas use conventional slide notes that are projected and then explained, illustrated and expanded upon using the board. Either individually or in groups, students work on and present topics in a seminar format, using selected reference sources. The module consists of lectures plus accompanying practical sessions. Students receive information on the installation and system requirements, and must then develop system prototypes under the supervision of lecturers in the laboratory.

Literature:

- McEwen, Adrian; Cassimally, Hakim (2013): Designing the Internet of Things. Online-Ausg. Hoboken: Wiley (EBL-Schweitzer). Available onlineat http://swb.eblib.com/patron/FullRecord.aspx?p=1471865.
- Meier, Reto (2012): Professional Android 4 application development. Indianapolis, Ind.: Wiley (Programmer to programmer).
- Poslad, Stefan (2009): Ubiquitous computing. Smart devices environments and interactions. 1. publ. Chichester: Wiley.
- Schiller, Jochen H. (2003): Mobile communications. 2nd ed. London: Addison-Wesley.
- Additionally, current articles from specialist journals and conferences as wellas Internet resources.

Module:	Cloud Computing
Code:	mkiB65
Subtitle:	
Course elements:	Lectures
Semester:	Every semester
Module coordinator:	Prof. Marcus Schöller
Lecturer:	Prof. Marcus Schöller
Language:	German, English
Allocation to the curriculum:	Compulsory subject,6th semester
Mode of teaching/semester hours per week (SWS):	Lectures 4 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	None
Mode of assessment:	Lectures: Written examination Practical sessions

Module objectives:

Nowadays, mobile computing and cloud computing depend on one another. Participants in this module are required to gain comprehensive knowledge of designing, developing and operating distributed applications, with a focus on the basic forms that cloud services and their delivery models take. This requires them to possess the knowledge taught by the prerequisites listed above. The Distributed Systems module provides the general foundations for web programming and web services.

Learning outcomes:

Knowledge:
Students who have successfully completed this module will possess knowledge of the principles and characteristics of cloud computing. They will be able to describe typical services and delivery models, and evaluate them on the basis of case studies. They will havedeveloped an understanding of the technical, organisational, commercial, legal, social and security-related aspects of cloud computing.

Skills:

Students are able to analyse the requirements of server services as well as develop and evaluate appropriate deployment variants. These variants range from in-house server solutions to hybrid cloud models and all the way through to straightforward cloud solutions. To do so, they apply a range of methods they have learned. Based on these requirements, students are able to develop services that use the characteristics of the cloud. Additionally, students are able to install and operate servers and cloud systems, which enables themto perform a more in-depth comparison of the various deployment variants. As a result, students are able to perform full-scale analyses and evaluations, and thus make technical decisions for service provision purposes.

Competencies:

LO#	Learning outcome	Assessed through
LO1	Possess and be able to apply an understanding of the various cloud business models (IaaS, PaaS, SaaS).	Written examination
LO2	Be able to correlate components with their tasks in a cloud architecture.	Written examination
LO3	Understand and be able to evaluate the operational aspects of a cloud infrastructure.	Written examination
LO4	Understand and be able to apply methods used in software development.	Written examination

Content:

Building on the Distributed Systems module, this module takes an in-depth look at some of the paths of development that led to cloud computing, specifically the use of TP monitors and application servers, the use of virtualisation technology, and grid computing.
The module presents the service models Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) from a provider's perspective anda user's perspective. The focus is on software development for the cloud and how a cloud system is operated. Students are taught about the public cloud, private cloud, hybrid cloud and community cloud delivery models on the basis of case studies. This focuses on how the models relate to mobile applications. The module considers, evaluates and discusses the technical, organisational, commercial, legal, social and security-related aspects of cloud computing in detail.

Forms of media:

Lectures in seminar format; slides and writing on the board; case study work in small groups.

Literature:

- Antonopoulos, Nick; Gillam, Lee (2010): Cloud Computing. Principles, Systems and Applications. London: Springer London (SpringerLink: Bücher, 0).
- Baun, Christian; Kunze, Marcel; Nimis, Jens; Tai, Stefan (2011): Cloud Computing. Web-basierte dynamische IT-Services. Berlin, Heidelberg: Springer Berlin Heidelberg (SpringerLink: Bücher).
- Buyya, Rajkumar (2011): Cloud computing. Principles and paradigms. Hoboken,NJ: Wiley (Wiley Series on Parallel and Distributed Computing).
- Velte, Anthony T.; Velte, Toby J.; Elsenpeter, Robert C. (2010): Cloud computing. A practical approach. New York, NJ: McGraw-Hill.

Module:	Introduction to Statistics and Biometrics
Code:	MTIB44
Subtitle:	
Course elements:	Lectures
Semester:	Summer semester
Module coordinator:	Prof. Oliver Burgert
Lecturer:	Prof. Oliver Burgert Prof. Christian Thies
Language:	German, English
Allocation to the curriculum:	Medical Informatics (Bachelor's), compulsory subject, 4th semester
Mode of teaching/semester hours per week (SWS):	Lectures 4 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	MTIB11, MTIB12, MTIB13, MTIB14, MTIB21, MTIB22
Mode of assessment:	Lectures/inverted classroom: Private study projects,project work

Module objectives:

This module teaches the basic principles of statistics and how this discipline is applied in medical contexts. It places significant emphasis on relating mathematical concepts to practical scenarios. During the module, students create their own questionnaire and use methods they have learned to evaluate it. This involves considering not only theoretical concepts associated with statistics, but also the many practical issues that arise when creatinga study or questionnaire. The module also looks at potential solutions.

Learning outcomes:

Knowledge:

- Methods of descriptive statistics and data visualisation.
- Statistical terms such as probability, variance, mean, median and quantile.
- Conditional probability, Bayes' theorem and probability distribution.
- Estimators, density functions and tests.
- Regression.

Skills:

After completing this module, students will be able to contextualise statistical measured valuesand perform statistics-based investigations themselves. They will be able to perform analysesin the statistics software R, and create a statistical evaluation for a studyor questionnaire. They will be able to design and carry out a study.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Understand and contextualise statistical terms. Avoid common errors when interpreting statistical statements.	Private study projects/project work
LO2	Apply statistical methods and implement them in Python and R independently.	Private study projects/project work
LO3	Design and implement a study.	Project work
LO4	Present study findings, including statistical evaluations, in written format.	Project work
LO5	Follow a specialist presentation on mathematics in English.	Private study projects

Content:

The module consists of two interwoven elements, the first of which presents and discusses the basic principles of statistics and data evaluation from a theoretical perspective and on the basis of practical examples. Its subject matter looks at methods of descriptive statistics and data visualisation, statistical terms such as probability, variance, mean, median, quantile, conditional probability, Bayes' theorem, probability distribution, estimators, density functions, tests and regression. It focuses heavily on how the concepts relate to practical scenarios and how they are applied, generally dispensing with mathematical proof (LO1, LO2, LO5).
The second element, running parallel to the first, teaches students practical applications through statistics programs (LO2). It presents how a clinical study is structured and performed,which includes the structure of questionnaires, how questions are formulated, and so on (LO3). Students then carry out a study in order to familiarise themselves with the practical issues that may arise in a scenario of this type (LO4).

Forms of media:

Statistical theory is taught using the flipped classroom concept, with students attending the Introduction to Statistics course at Udacity Open Online University. The teaching content provided in this is divided into sections that the students have to complete in two-week blocks. The sections cover mathematical arithmetic tasks, concept-based questions and programming tasks in the programming language Python. The content of the blocks is then implemented and put into practice using examples, in contact time sessions of 4 SWS. Students work on specific aspects of applying statistical methods in medical applications andlook at frequently encountered errors. The time also includes teaching knowledge of R, questionnaire and studydesign, and how to consider specific issues in medical statistics, in seminar format using PowerPoint presentations and information written on the board. Parts are preprogrammed ona computer in both elements of the module.

Literature:

- http://www.r-project.org/
- https://www.udacity.com/course/st101

Module:	Medical Information Systems
Code:	MTIB65
Subtitle:	
Course elements:	Lectures Practical sessions
Semester:	Every semester
Module coordinator:	Prof. Christian Thies
Lecturer:	Prof. Christian Thies
Language:	German
Allocation to the curriculum:	Medical Informatics (Bachelor's), compulsory subject, 6th semester
Mode of teaching/semester hours per week (SWS):	Lectures 2 SWS Practical sessions 2 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequistes:	MTIB26 MTIB27, MTIB41, MTIB42, MTIB43 MTIB44, MTIB45, MTIB26, MTIB27
Mode of assessment:	Lectures: Project work

Module objectives:

This module represents the first time that the skills learned in previous modules are brought together. Students learn which resources are actually involved in creating an information system. This involves learning the need to perform careful modelling at all levelsof abstraction. An important goal of the module is for students to recognise that, although an information system does consist of components that are easy to understand, bringing themtogether creates a highly complex situation that it is no longer possible to follow intuitively. Students are expected to recognise and accept the value of careful and sustainable planningduring the requirements analysis, design, implementation and setup stages, and to accept that an intuitive procedure might lead to unusable software that cannot be maintained.Additionally, they should recognise the need for standardised development and lifecycle management. In addition to becoming familiar with technical aspects, students must becomeaware that information systems inevitably require a constant mergingof personal and sensitive data that may be used for purposes other than clinical care.

The required level of data protection must be taken into account as early as the implementation planning stage; that is, from the outset.

Learning outcomes:

Knowledge:

Students learn the architecture of medical information systems and the special features that arise from various domains. The module looks at service providers such as hospitals, medicalpractices, laboratories and non-medical practices. Where service financers are concerned, this relates to the billing systems used at health insurance companies.In institutions,it involves catalogues such as ICD10/DRG SNOMED and MeSH.
In particular, the module focuses on the logical combination of all data for model-supported therapy and personalised medicine in the form of a central electronic patient record. For this purpose, it presents the relevant interfaces and communication techniques, as well as data modelling and application integration. In addition to software distribution, it introduces frameworks for data security, persistence and service-oriented architectures.

Skills:

Students learn and apply the planning and development of components for complex, interactive systems. This involves applying methods from the fields of software engineering, distributed systems, IT security, process analysis and interface design. In additionto implementing the technical aspects, students apply organisational measures drawn primarily from requirements analysis and subsequent operation. Working as a team, students learn how to plan a larger piece of software, distribute tasks, implement tasks and pool the findings.The key component is role-based authorisation management and the division of data in the database so that the main aspects of data protection can be supported as effectively as possible, as early as the system design stage. In this context, studentslearn how to integrate access restrictions and organise all the access functions accordingly. Another fundamental technique that students are required to learn is data mapping for configuring and implementinginterfaces between components.

Competencies:

The aim is to develop complete systems thinking across device and application borders, but at the same time to deliver a concrete implementation of a stand-alone application. The module puts into practice the relationship between independently developed components

and partial applications of other developers. This includes efficiently standardised and structured communication for each component function and interface. Students demonstrate that they have acquired these competencies over the course of the semester by developing individual components in small groups, working in accordance with software engineering rules and combining their functions with applications developed by other groups. The artifact created is the software and the associated documentation forall the software engineering measures.

LO#	Learning outcome (LO)	Assessed through
LO1	Be able to develop complete systems thinking across device and application borders	Project work
LO2	Be able to deliver a concrete implementation of a stand-alone application	Project work
LO3	Learn the relationship between independently developed components and partial applications of other developers	Project work
LO4	Understand and be able to design interfaces, as well as implement them using standardised methods and document them	Project work
LO5	Be familiar with the key concepts of information systems and implement them in components	Project work

Content:

This module presents the components of medical information systems, such as patient data management, laboratory value storage, authorisation management, results management, rawdata storage, and so on. Groups are then formed, with each working on a component over the course of the semester. At specified deadlines, interim findings are presented on the basis of the V-Model used in software engineering.
The final stage involves all the components being installed on a project server.

Forms of media:

The components of the module are taught in lecture format. During the development stages, joint practical sessions are held with the aim of clarifying specific technical questions.The milestone dates are the seminars. A workshop combining all the components completesthe module.

Literature:

- Haas, Peter (2005): Medizinische Informationssysteme und ElektronischeKrankenakten. Berlin, Heidelberg: Springer Berlin Heidelberg (SpringerLink: Bücher).
- Vetter, Max (1994): Informationssysteme in der Unternehmung. Eine Einführung in die Datenmodellierung und Anwendungsentwicklung. 2nd edition, revised. Stuttgart: Teubner (Informatik und Unternehmensführung).
- Winter, Alfred (c2011): Health information systems. Architectures and strategies.2nded. London: Springer.

Module:	Bachelor's Thesis
Code:	mkiB75
Subtitle:	
Course elements:	Thesis
Semester:	Every semester
Module coordinator:	Professors Directors
Lecturer:	Professors from the degree programme
Language:	Tob e discussed
Allocation to the curriculum:	Compulsorysubject, 7th semester
Mode of teaching/semester hours per week (SWS):	Thesis
Total hours:	Independent study 360 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	Passes in all modules from the first 5 semesters
Recommended prerequisites:	All modules from the first 6 semesters
Mode of assessment:	Bachelor's Thesis

Module objectives:

By passing this module, students demonstrate that they are able to produce a piece of work on an issue faced in the field of media and communication informatics, and that they are able to do so independently, by a specified deadline, and using fundamental scientific methods.

The Bachelor's thesis contributes to the overall learning objectives relating to media and communication informatics in the following ways:

- Wide-ranging interdisciplinary specialist knowledge and extensive methodological skills: a Bachelor's thesis requires students to apply knowledge and methods from a range of disciplines. This covers informatics-related, software-related, media-related, psychological, didactic and business-related aspects, as well as others besides.
- Attractive career prospects*:* Bachelor's theses often deal with problems that are relevant to current business practice in informatics-related fields. A Bachelor's thesis can be written as an external piece of work in conjunction with a company.

- International perspective: Bachelor's theses may be written in English. They may also be completed in conjunction with institutions in other countries.

Learning outcomes:

Knowledge:

- Research based on serious sources.
- Cite text passages correctly.
- Reference sources.
- Demonstrate in detail a subject area, its context and its most recent developments.
- Clearly formulate a research question and the objectives of a thesis.
- Precisely describe methods and procedures, and prepare artifacts.
- Prepare key points in a structured way.
- Make coherent arguments and back up statements.
- Demonstrate work in a convincing, understandable way.

Skills:

Students conduct literature research on the basis of scientific sources. They prepare workon the latest findings in the subject area, taking a critical approach. They analyse problems, present hypotheses, define requirements and derive criteria for systematically evaluating alternatives. Students break down the problems they are working with into individual tasks, develop concepts for creating solutions, and critically assess the findings. They create prototypes or operational artifacts. Students communicate findings clearly and in a format that is suitable for academic purposes.

Competencies:

LO#	Learning outcome (LO)	Assessed through
LO1	Independent scientific work on a subject area relating to media and communication informatics	Thesis document
LO2	Work on a straightforward problem and a small-scale artifact using basic methodology	Thesis document
LO3	Write a scientific thesis independently	Thesis document
LO4	Present own work in a comprehensible, clearly structured and concise format	Thesis document

Content:

Bachelor's theses generally examine practical problems and solutions – and in some cases theoretical ones – relating to media and communication informatics.

Forms of media:

Subject-specific and methodological supervision of Bachelor's thesis through discussion and commentary on drafts.

Literature:

- Deininger, Marcus (2005): Studien-Arbeiten. Ein Leitfaden zur Vorbereitung Durchführung und Betreuung von Studien- Diplom- Abschluss- und Doktorarbeiten am Beispiel Informatik. 5th edition, revised. Zurich: vdf Hochschulverl. an der ETH.
- Ebel, Hans F.; Bliefert, Claus (2009): Bachelor-, Master- und Doktorarbeit.Anleitungen
- für den naturwissenschaftlich-technischen Nachwuchs. 4th edition, updated. Weinheim: Wiley-VCH.
- Esselborn-Krumbiegel, Helga (2008): Von der Idee zum Text. Eine Anleitung zum wissenschaftlichen Schreiben. 3rd edition, revised. Paderborn, Munich, Vienna, Zurich: Schöningh (utb.de Bachelor-Bibliothek, 2334: Schlüsselkompetenzen, Kernkompetenzen).
- Grieb, Wolfgang; Slemeyer, Andreas (2012): Schreibtipps für Studium, Promotion und Beruf in Ingenieur- und Naturwissenschaften. 7th edition. Berlin: VDE-Verl.
- Karmasin, Matthias; Ribing, Rainer (2012): Die Gestaltung wissenschaftlicher Arbeiten. Ein Leitfaden für Seminararbeiten Bachelor- Master- und Magisterarbeiten sowie Dissertationen. 7th edition, updated. Vienna: facultas.wuv (UTB, 2774: Schlüsselkompetenzen).

Module:	Media and Communication Informatics Project 1
Code:	mkiBW101
Subtitle:	
Course elements:	Practical sessions
Semester:	Every semester
Module coordinator:	Prof. Peter Hertkorn
Lecturer:	Professors from the degree programme
Language:	German, English
Allocation to the curriculum:	Compulsory elective, 6th semester
Mode of teaching/semester hours per week (SWS):	Practical sessions 2 SWS
Total hours:	Contact time 30 hours Independent study 120 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	None
Mode of assessment:	Practical sessions

Module objectives:

This module aims to help students apply the knowledge and skills they have acquired during the degree programme to problems relating to the field of media and communication informatics, working on the basis of a practical case study. The problems are generally drawn from both media-related subject areas and software implementations. In particular,this requires students to harness their communication and team skills, as they are tasked with working on the problems independently within work groups.

The first part of the project focuses on creating prototypes and the development process associated with this.

Learning outcomes:

Knowledge:
Consolidation of knowledge acquired during studies in relation to the individual steps involved in the development process:

- Process models.
- Project planning and management methods.

- Requirements analysis techniques.
- Resource usage estimation process.
- Methods and processes involved in modelling, design and system implementation.
- Use of various test methods.
- Methods for documenting findings.

Skills:

Students analyse a set problem and apply methods and processes for define requirements, create models, design systems, implement systems and perform tests. They analyse problems, evaluate a range of potential solutions, and develop solutions independently. They work independently within a project team; this setting requires them to plan the project, divide up tasks and compile the findings at a later point. They are able to document the findings from their team's activities in an appropriate manner and present them to an expert audience in a comprehensible way.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Apply methods and processes for systematic development of products and software systems.	Artifact
LO2	Analyse a problem, devise and evaluate alternative solutions, develop methods on this basis, and put forward well-reasoned arguments in critical discussions.	Artifact
LO3	Document the solutions that have been developed and present them to an expert audience.	Artifact, presentation
LO4	Work as part of a team in order to define goals, pursue them and achieve them together.	Artifact, presentation
LO5	Use professional tools for the entire development process.	Artifact

Content:

Project teams work on a topic chosen from a range of options provided by the lecturers. In coordination with the supervisors, they structure the project into appropriate development stages. In the process, they define a work plan and a schedule for the project; these also contain regular meetings with the supervisors. At each of the milestones, the findings are documented and presented, and the stage reached by prototypes is also demonstrated.

Forms of media:

Project work in a team with supervision by the lecturer. Specification, development, testing and documentation activities; presentation of findings. Technical work documents and the necessary hardware and software are provided. Students are required to obtain and work through the necessary project documentation themselves, using their own initiative.

Literature:

Students will be informed of literature sources during the projects and must research these themselves.

Module:	Media and Communication Informatics Project 2
Code:	mkiBW201
Subtitle:	
Course elements:	Practical sessions
Semester:	Every semester
Module coordinator:	Prof. Peter Hertkorn
Lecturer:	Professors from the degree programme
Language:	German, English
Allocation to the curriculum:	Media and Communication Informatics (Bachelor's), compulsory elective, 7th semester
Mode of teaching/semester hours per week (SWS):	Practical sessions 2 SWS
Total hours:	Contact time 30 hours Independent study 120 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	Media and Communication Informatics Project 1
Mode of assessment:	Practical sessions

Module objectives:

This module aims to help students apply the knowledge and skills they have acquired during the degree programme to problems relating to the field of media and communication informatics, working on the basis of a practical case study. The problems are generally drawn from both media-related subject areas and software implementations. In particular,this requires students to harness their communication and team skills, as they are tasked with working on the problems independently within work groups.

During the second part of the project, the focus is on developing product prototypes and introducing the product to an operating environment.

Learning outcomes:

Knowledge:

- Be familiar with methods for developing prototypes into a product.
- Be familiar with processes for evaluating user-friendliness.

- Be familiar with aspects that need to be taken into account when introducing products or installing software systems in operating environments.
- Be familiar with methods for presenting and marketing products.
- Be able to research information on the subject of licences and patents.

Skills:

Students apply methods and processes for developing prototypes until they reach product maturity. They conduct tests for evaluating user-friendliness and, on this basis, derive modifications for product development. They introduce products to existing operating environments and set up suitable support structures. They create product presentations and research licensing conditions, as well as industrial property rights. They work independently within a project team, are able to document the findings from their team's activitiesin an appropriate manner, and are able to present them to an expert audience in a comprehensible manner.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Apply methods and processes for developing a prototype until it reaches the point of product maturity.	Artifact
LO2	Conduct tests for evaluating the user-friendliness of a product.	Artifact
LO3	Introduce a product to existing operating environments.	Artifact, presentation
LO4	Document findings and present them to an expert audience.	Artifact, presentation
LO5	Work as part of a team in order to define goals, pursue them and achieve them together.	Artifact, presentation
LO6	Use professional tools for installation, operation and product presentation purposes.	Artifact

Content:

Project teams continue developing the prototypes they began during the first part of the Media and Communication Informatics Project, up to the point at which the products reach maturity. In coordination with the supervisors, they structure the project into appropriate development stages. In the process, they define a work plan and a schedule for the project; these also contain regular meetings with the supervisors. At each of the milestones, the findings are documented and presented, and the stage reached by the product is also demonstrated.

Forms of media:

Project work in a team with supervision by the lecturer. Specification, development, testing and documentation activities; presentation of findings. Technical work documents and the necessary hardware and software are provided. Students are required to obtain and work through the necessary project documentation themselves, using their own initiative.

Literature:

Students will be informed of literature sources during the projects and must research these themselves.

Master:

Module:	Data Management and Analytics
Code:	wiM24
Subtitle:	Advanced Data Management Analytical DataProcessing and Data Warehousing
Course elements:	Lectures
Semester:	Every semester
Module coordinator:	Prof. Dr, Ilia Petrov
Lecturer:	Prof. Dr, Ilia Petrov
Language:	English, German
Allocation to the curriculum:	Compulsory eletive 2nd semester
Mode of teaching/semester hours per week (SWS):	Lectures 4 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	None
Mode of assessment:	Lectures:Written coursework, presentation

Module objectives:

The lectures in this module concentrate on the inner workings of databases as wellas architectures and algorithms. They provide students with an introduction to the basicsof storage management, buffer management, query processing, transaction management and index structures. Additionally, they examine the basic principles of system architecture as well as the procedures and approaches involved in analytical data processing. Their specific areas of focus are data organisation, models, query optimisation and execution, index support, statistics, histograms and special operators (CUBE, skyline).The module also covers every stage in the process from transaction-oriented data storage, data warehouse modelling and multidimensional data storage through to analysis tools, and teaches the technical principles underpinning business intelligence systems

Learning outcomes:

Knowledge:

- Be able to describe the architecture and algorithms associated with database systems.
- Know and be able to use algorithms for query processing and transaction
- management, index structures, and storage organisation and management.
- Be familiar with the approaches to and algorithms used in analytical data processing.
- Be able to describe data models for analytical systems.
- Be able to explain data storage and organisation.
- Be familiar with query processing and optimisation (OLAP)
- Be able to use advanced operators (CUBE, top-k, skyline).
- Be familiar with aggregates, indices and materialised views
- Be able to describe systems and system architectures

Skills:

Students analyse information and database systems. To do so, they apply a range of methods they have learned. They develop concepts and solutions for transaction-oriented data storage. They are able to show the internal components of databases in abstracted form. They develop concepts and techniques for analytical query processing.

Competencies:

After completing this module, students will be able to acquire the information they needto model a database. They will be able to analyse the available data critically and determine what steps should follow next on the basis of this. They will be able to familiarise themselves with a new area quickly using the information that is available. Students will be able to compare the architectures of various data storage systems with one another. They will also be able to compare different algorithms for buffer management, query management and indexing under a range of conditions.

Content:

- Basics of database storage management.
- Basics of buffer management algorithms
- Query processing and optimisation.
- Transaction management.
- Access paths and index structures.
- OLAP.

Forms of media:

Literature:

- Härder, T., Rahm, E. (199): Datenbanksysteme - Konzepte und Techniken der Implementierung. Springer.
- H. Garcia-Molina, J. Ullman, J. Widom (2008): Database Systems: The Complete Book (2nded.). Prentice Hall Press.
- Ramakrishnan, R., Gehrke, J. (2003): Database Management Systems. 3rd Ed., McGrawHill.
- Arthur J. Bernstein and Michael Kifer (2001): Databases and Transaction

Processing: AnApplication-Oriented Approach (1st ed.). Addison-Wesley Longman Publishing.

- Weikum, G., Vossen, G. (2002): Transactional Information Systems. Morgan Kaufmann.
- Gray, J., Reuter, A. (1993): Transaction Processing: Concepts and Techniques. MorganKaufmann.
- Bernstein P, Newcomer E. (2009): Principles Of Transaction Processing (2 ed.), MorganKaufmann.
- Yu C., Meng, W. (1998): Principles of Database Query Processing for AdvancedApplications. Morgan Kaufmann Publishers Inc.

Module:	Innovation for Sustainable Business	
Code:	wiM19	
Course elements:	Lectures	
Semester:	Every semester	
Language:	English	
Mode of teaching/semester hours per week (SWS):	Lectures	4 SWS
Total hours:	Presence	60 hours
	Self directed	90 hours
Credits:	5 ECTS	
Mode of assessment:	Presentation, Continuous Assessment	

Module objectives:

This module delves into the interrelationships of innovation, business models and sustainability. Students will learn about the latest theories and practices related to sustainable innovation and business models and how they can be applied in different organizational contexts. Technology and innovation are considered in their central role for digital transformation and enabling sustainable business models.

Intended Learning outcomes:

Knowledge:

- Students will understand the concept of Sustainable Business and the importance of innovation and business model for it.
- They learn the latest practical trends and research results in the field of sustainable business
- Students will know different types of sustainable business models as well as real companies with these business models
- They will understand the challenges and opportunities associated with sustainable innovation in different industries.
- Students will understand the importance of stakeholder engagement for Sustainable Businesses

Skills:

- Students will be able to critically analyze the environmental and social impacts of business activities using real-world examples.
- Students can evaluate the sustainability of existing business models and identify opportunities for sustainable innovation
- They assess innovative business ideas for their economic, ecological and social viability

Competencies:

- They are able to apply sustainability principles to real business challenges
- Students have the ability to design sustainable business models that balance economic, social and environmental factors
- Students will be able to develop and communicate business cases in the topic area of sustainable business
- They can develop sustainable innovation strategies in different organizational contexts

Content:

- Theoretical foundations for sustainable business
- Principles of sustainable business systems, e.g. circular economy/closed loop systems
- Innovation as a driver of new business models
- Frameworks for the development of sustainable business models, e.g. Triple Layered Business Model Canvas
- Archetypes of sustainable business models
- The role of information technology as an enabler of sustainable business models
- Case studies on sustainable businesses

Forms of media: Interactive lecture and exercises, guest lectures and case studies

Literature:

- De Angelis, R. (2018). Business models in the circular economy: Concepts, examples and theory. Springer.
- Lüdeke-Freund, F., Carroux, S., Joyce, A., Massa, L., & Breuer, H. (2018). The sustainable business model pattern taxonomy—45 patterns to support sustainability-oriented business model innovation. Sustainable Production and Consumption, 15, 145-162.

Module:	Interactive Systems	
Code:	hucM101	
Subtitle:		
Course elements:	Lectures	
Semester:	Every semester	
Module coordinator:	Prof. Dr. Gabriela Tullius	
Lecturer:	Prof. Dr. Gabriela Tullius	
Language:	German, English	
Allocation to the curriculum:	Compulsory elective, 1st semester	
Mode of teaching/semester hours per week (SWS):	Lectures	4 SWS
Total hours:	Contact time Independent study	30 hours 120 hours
Credits:	5 ECTS	
Prerequisites in accordance with examination regulations (StuPro):	None	
Recommended prerequisites:	None	
Mode of assessment:	Lectures: Participation, private study projects, project work, presentation	

Module objectives:

Interactive Systems contributes to the overall huc learning objectives in the following ways: Comprehensive methodological skills: Students become familiar with methodology in the fields of software technology, informatics, design, psychology and information science, and learn how to apply and evaluate it analytically. Social and communication skills: Discussing various approaches and possibilities in a team setting is a key feature of the module. Students at Master's level are expected to be ableto analyse and, where applicable, bring together different elements and approaches. They hone these skills by giving their own presentations as well as formulating theses and discussing them.
Attractive career prospects: Interactive systems, their design and the usability experiencein particular are playing an increasingly important role in the industry.

Learning outcomes:

Knowledge:

- Be familiar with and able to evaluate methods for designing user interfaces.
- Be able to design and evaluate applications based on the user-centred design process.
- Be able to apply criteria for analysing and evaluating user interfaces.
- Be able to evaluate the use of guidelines and standards in designing interactive systems.
- Be able to classify, analyse and apply different usability engineering techniques.
- Be able to design and evaluate a user interface from an ergonomic and an aestheticperspective.
- Be able to understand the user experience as an all-embracing extension of usability.
- Be able to understand, analyse and contextualise research work in the field of interactivesystems, and establish how it relates to the student's own work.

Skills:

Students analyse the user group, the context and the task of the user. To do so, they apply a range of methods they have learned. Students describe criteria for analysing interactive systems in a wide range of different areas. They evaluate user interfaces based on scientific criteria and are able to develop graphical window systems, for example, as well as other interactive systems using appropriate interaction objects. This area of study considers bothoutput and input elements. Students also design applications with respect to accessibility (in the context of interactive systems) and are able to evaluate applications with this in mind. Students design mockups and prototypes for immediate or later implementation as attractive products that are fit for purpose. In the process, they consider and evaluate the product as a whole from the perspective of the user experience and user needs. Elements of concept testing, persuasive design and gamified design are applied here. Students choose a designthat is appropriate for the input and output modalities in question.

Competencies:

After completing this module, students will be able to do the following:

L0#	Learning outcome (LO)	Assessed through
LO1	Demonstrate their familiarity with methodology in the fields of software technology, informatics, design, psychology and information science, and how to apply and evaluate it analytically..	Private study projects, presentatio n
LO2	Analyse and evaluate interactive systems according to the applicable ISO standard.	Private study projects, project work
LO3	Identify and apply approaches to the user experience.	Hausarbeit, Projektarbeit
LO4	Analyse, synthesise (e.g. design patterns) and apply research work conducted in the field of interactive systems.	Private study projects, presentation ,project work
LO5	Social and communication skills: Discussing various approaches and possibilities in a team (comprising all the module attendees in this case) is a key feature of the Interactive Systems module. Students at Master's level are expected to be able to analyse and, where applicable, bring	Presentation, private study projects, projectwork

	together different elements and approaches.	

This module focuses on approaches to developing interactive products from a wide range of different perspectives. It considers not only micro-HCI, but also macro-HCI. Examples include multi-touch systems, desktop PCs, various types of mobile device, as wellas interactive 3D environments and robots of all kinds. Interactive systems have a variety of applications, such as interaction with large data quantities, in a three-dimensional space and in multimodal contexts. This covers an extensive spectrum from CCI (child computer interfaces) all the way through to medical applications. The module addresses issues relatingto design in the context of use and, in particular, the needs of different interactive products plus their formal descriptions(LO1).It starts by discussing general questions concerning user and task modelling, and by analysing a range of techniques on the basis of current research literature (LO1). Various design issues, standards, methods and approaches are discussed in the context of creating interactive products. Usability engineering and the user experience represent two cornerstones of the module. There is a focus on not only embedding usability-based thinkingin the software creation process and general business practice, but also evaluating interactive products and assuring their quality. As part of this, the application of ISO standards such as ISO 9241 is explained and demonstrated on the basis of selected examples (LO2), as is the use of design patterns – something that is becoming increasingly important to this field (see Tidwell 2011; LO4). The module also discusses the user experience, still a relatively new subject area, from the perspective of user needs (LO3). This considers approaches to research drawn from the fields of concept testing and joy of use.The aim is for students to embed these approaches into and synthesise them with related areas of work and their own work (LO4). Students are encouraged to identify research issues as well as formulate and work on theses in the subject area by regularly studying articles from relevant scientific conferences and journals (LO5).

Content:

Project teams work on a topic chosen from a range of options provided by the lecturers. In coordination with the supervisors, they structure the project into appropriate development stages. In the process, they define a work plan and a schedule for the project; these also contain regular meetings with the supervisors. At each of the milestones, the findings are documented and presented, and the stage reached by prototypes is also demonstrated.

Forms of media:

Teaching in seminar format with supervision by lecturer. Students work on a range of subjects with the aid of suitable scientific literature. Subject areas and projects are generally worked on in small teams. The aim of this is for team members to exchange thoughts and ideas; the team setting helps students to do so. Students acquire extracts from literature themselves.

Literature:

- Bowman, Doug A. (2005): 3D user interfaces. Theory and practice. Boston, Mass.,Munich:Addison-Wesley.
- Jones, Matthew; Marsden, Gary (2006): Mobile interaction design. Chichester,

Weinheim: Wiley.

- Markopoulos, Panos (2008): Evaluating children's interactive products. Principles and practices for interaction designers. San Francisco, Calif., Amsterdam, Heidelberg: Morgan Kaufmann; Elsevier Science (The Morgan Kaufmann series in interactive technologies).
- Mayhew, Deborah J. (1999): The usability engineering lifecycle. A practitioner's handbook for user interface design. San Francisco, Calif.: Morgan Kaufmann (The Morgan Kaufmannseries in interactive technologies).
- Preece, Jenny; Rogers, Yvonne; Sharp, Helen (2002): Interaction design. Beyond human- computer interaction. New York, NY: Wiley.
- Sarodnick, Florian; Brau, Henning (2006): Methoden der Usability Evaluation. Wissenschaftliche Grundlagen und praktische Anwendung. 1st edition, Bern: Huber (Praxisder Arbeits- und Organisationspsychologie).
  Shneiderman, Ben; Plaisant, Catherine (2005): Designing the user interface. Strategies foreffective human-computer interaction. 4th ed. Boston, Mass., Munich: Pearson/Addison- Wesley. ed. Beijing, Cologne: O'Reilly.
- Tullis, Tom; Albert, Bill (2013): Measuring the User Experience. Collecting, Analyzing, andPresenting Usability Metrics. Online edition. Amsterdam: Elsevier
- ISO standards (e.g. from the 9241 series).
- Conference papers and ACM/IEEE journals, e.g. SIGCHI.

Module:	Formal Methods of Human-Centered Computing
Code:	hucM104
Subtitle:	
Course elements:	Lectures
Semester:	Every semester
Module coordinator:	Prof. Natividad Martinez Madrid
Lecturer:	Prof. Natividad Martinez Madrid
Language:	German, English
Allocation to the curriculum:	Human-Centered Computing (Master), compulsory subject, 1st semester
Mode of teaching/semester hours per week (SWS):	Lectures 4 SWS
Total hours:	Contact time 60 hours Independent study 90 hours
Credits:	5 ECTS
Prerequisites in accordance with examination regulations (StuPro):	None
Recommended prerequisites:	None
Mode of assessment:	Lectures:Private study projects,presentation

Module objectives:

This module aims to teach students the basic principles of formal mathematical methods used in human-centered computing. Students will be able to design and apply empirical methods. They will also be able to analyse and discuss complex mathematical texts in the field of artificial intelligence. Finally, students will have the ability to familiarise themselves with a mathematical topic in the area of human-centered computing, formulate information on it from a sound scientific standpoint, and present it in a comprehensible, appropriate format. After taking this module, students will have the mathematical skills required to obtain a Master's degree.

Learning outcomes:

Knowledge:

Students know the basic principles of empirical research design and are ableto distinguish between qualitative and quantitative methods. Students know the basic principles of probability calculation and statistical modelling,including both descriptive statistics and causal inference, and particularly linear regression.
Students ascertain the principles of artificial intelligence environments, particularlythose relating to machine thinking.

Skills:

Students plan and design empirical research studies. In the process, they analyse and evaluate the data that has been collected.
Students calculate statistical parameters using specified data sets and apply inearregression in order to find solutions to simple examples.
Students evaluate which machine thinking method is most appropriate for solving a given problem.
Students design a practical application for a selected formal method of human-centered computing.

Competencies:

After completing this module, students will be able to do the following:

LO#	Learning outcome (LO)	Assessed through
LO1	Plan an empirical study and evaluate the findings.	Presentation
LO2	Provide reasoning for the suitability of different empirical methods to a certain research design approach.	Presentation
LO3	Work independently to identify information on the subject of formal methods and analyse complex mathematical texts.	Private study projects
LO4	Work in a team in order to find solutions to complex tasks.	Private study projects
LO5	Structure information on a subject relating to the discipline of formal methods in an accurate, understandable way.	Private study projects
LO6	Capably present and discuss a subject area relating to the discipline of formal methods, using specialist language.	Presentation

Content:

The lectures use the flipped classroom teaching principle. Based on this, students receive material before the classroom sessions and are required to familiarise themselves with it (LO3). Students receive an introduction to the materials as well asquestions and background information for discussions, and should work through this. Classroom sessions are conducted in a seminar format. They start by answering anyunresolved questions and then move on to a discussion of the topic in question, with presentations where applicable (LO1, LO2). During the second half of the lecture, students select a topic from the area of formal methods of human-centered computing and familiarise themselves with it independently, under the supervision of the lecturer (LO3, LO4). This enables them to prepare work

containing theoretical and practical components (LO4, LO5). This work is also demonstrated in presentations (LO6). There are two subject areas from which the topics are drawn:

1. Empirical methods of human-centered computing. This looks at the basic principles of research design [Creswell 2003]. Following a review of the basicprinciples involved in probability calculation [Meinel 2009], students are introduced to more advanced statistics and causal inference concepts [Freedman2005 and2010]
2. Selected areas of artificial intelligence, particularly machine learning; thisincludes artificial neural networks and fuzzy logic [Lippe 2006]

Forms of media:

Before the classroom sessions, students receive material in the e-learning platform (chapters from literature sources or selected texts, as well as other multimedia references) and are required to familiarise themselves with it; they also receive an introduction and background information for discussions. Classroom sessions are conducted in a seminar format with a board, an overhead projector or presentation methods. During the second half of the lecture, the work that has been prepared in private study projects is combined in a document and presented using slides on a projector linked to a PC.

Literature:

- Creswell, John W. (2003): Research design. Qualitative quantitative and mixedmethods approaches. 2nd ed. Thousand Oaks, Calif.: Sage.
- Freedman, David (2005): Statistical models. Theory and practice. 1st publ. Cambridge: Cambridge University Press.
- Freedman, David; Collier, David; Sekhon, Jasjeet Singh; Stark, Philip B. (2010):Statistical models and causal inference. A dialogue with the social sciences. Online edition. Cambridge, New York: Cambridge University Press.
- Lippe, Wolfram-Manfred (2006): Soft-Computing. Mit Neuronalen Netzen Fuzzy- Logic und Evolutionären Algorithmen. Berlin, Heidelberg: Springer BerlinHeidelberg (SpringerLink: Bücher).
- Meinel, Christoph; Mundhenk, Martin (2009): Mathematische Grundlagen derInformatik. Mathematisches Denken und Beweisen; eine Einführung. 4th edition revised. Wiesbaden: Vieweg + Teubner (Studium).

Additionally, current articles from specialist journals and conferences aswell as Internet resources.