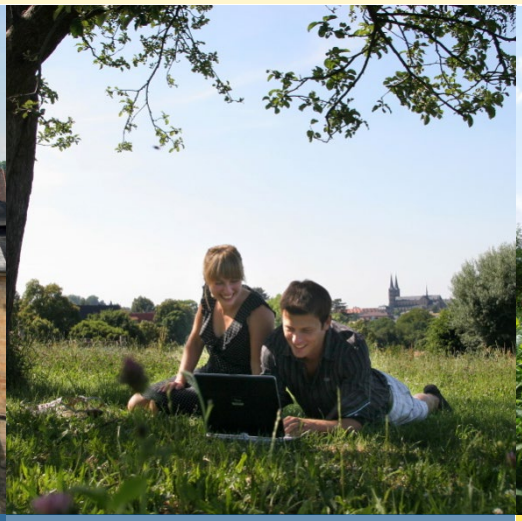
Faculty of Information Systems and Applied Computer Sciences (WIAI)

Undergraduate and Graduate Studies in Information Systems and Computer Science

Module Handbook and Student Guide Academic Year 2025-2026


WIAI

www.uni-bamberg.de/wiai

Contact

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Legal notice

Contents

1 Introduction and General Information

This handbook lists all modules offered in the Faculty of Information Systems and Applied Computer Sciences during the academic year 2025-2026.

To prevent problems arising from late changes on these offerings, you are advised to confirm module specifications and schedules through the research groups' web pages or directly with the responsible teaching staff. There may also be new courses becoming available on short notice. Please see the faculty's web pages for relevant announcements. The official German module handbooks for the various degree courses can be accessed through the following links:

- B.Sc. Angewandte Informatik
- B.Sc. International Information Systems Management
- B.Sc. Informatik: Software Systems Sciences
- B.Sc. Information Systems (Wirtschaftsinformatik)
- M.Sc. Applied Computer Sciences
- M.Sc. Computing in the Humanities
- M.Sc. International Software Systems Science
- M.Sc. Information Systems (Wirtschaftsinformatik)
- M.Sc. International Information Systems Management

1.1 Fees and Registration

All modules are currently open free of charge to foreign guest students who will study at Bamberg University within the frame of a partnership exchange programme, such as ERASMUS+. There are no tuition or bench fees. Enrolment with the University incurs a nominal registration fee covering administration charges, student union membership (*Studierendenwerk*) and the City of Bamberg travel ticket.

Information on the registration and enrolment process may be obtained from the International Office who will also be able to advise you on any exchange scheme that may exist between Bamberg University and your home institution.

Once admitted to and enrolled with Bamberg University you do not need to register for attending a teaching module. Feel free to sit in and participate in any course offering that fits your educational needs and time table. Be aware, though, that some courses may have entry requirements and/or class size restrictions.

1.2 Teaching Times

The academic year 2025-2026 consists of two teaching periods. Winter semester at Germany Universities always starts on October, 1st, and ends on March, 31st. Summer semester always starts on April, 1st, and ends on September, 30th. Lectures usually start two weeks later:

- Winter Semester lecture start: 13th October 2025 – 06th February 2026,
- Summer Semester lecture start: 13th April 2026 – 17st July 2026.

All deadlines and dates can be also found here: https://www.uni-bamberg.de/en/studies/currently-enrolled/study-organization/deadlines-and-dates/

1.3 Assessment

The course assessment is done mostly by written exams and optionally also by way of homework assignments and/or lab practicals. In a number of cases, typically for graduate level modules, the final exam is oral.

Final written exams are usually held immediately after the end of the lecture period, i.e. February/March for the Winter Semester and end of July/August for the Summer Semester. Make sure you plan your travelling so you are in Bamberg during the exams.

Be aware that there are firm deadlines for exam registration some time at the end of the first half of the semester. Watch out for the emails announcing the registration period and check up with your class mates if you are not sure. There is a short period of time during which you can deregister from an exam. Once this period has passed and you are registered you **must take** the exam at the specified day and time. Also, if you miss the online registration deadline, then you **cannot participate** in the exam.

There is one more thing to know: For written exams the registration in FlexNow2 is sufficient. For oral exams, however, you also need to arrange an exam time with the lecturer in addition to the FlexNow2 registration.

If for some reason you cannot attend the regular written exam, say because you are required to return home early, talk to the course lecturer before the FlexNow2 registration period has passed. There are two options:

- **Option 1:** The course lecturer may be able to arrange an oral exam for you at an earlier date instead.

  In this case, because you are not writing the official exam, you **must not register** with the FlexNow2!

  system.

- **Option 2:** It is sometimes possible that we schedule the regular exam at your Home University on the same day and at the same time when it is written in Bamberg. For this option you **must register** via FlexNow2!

Please contact the Career & International Center early to obtain advice on how to arrange remote exams. Whether such options are available is entirely at the discretion of the course lecturer.

The official exam language is German, but many courses may offer written or oral exams in English if required. Some modules are fully taught in English, some only at the discretion of the lecturer. If you need to be set an English exam for a module delivered in German you should contact the module lecturer early to find out if this is possible. The description of each module listed below in this booklet indicates if all or some part of the module is delivered in English.

1.4 Workload

The module descriptions below specify the total module workload in terms of ECTS (European Credit Transfer System) credit points according to the following approximate accounting scheme:

- 1 ECTS = 25-30 hrs total student workload (all inclusive)
- 30 ECTS = total module load per semester
- 6 ECTS = single standard course module of 4 contact hrs/week, combining lectures + tutorials

1.5 Course Levels and Teaching Format

In line with our traditional Diploma degree structure, modules are taught at 2 levels:

- *Basic Studies*

  These are foundational and introductory courses in the general disciplines of Information Systems, Applied Computer Science and Software Systems Science corresponding to the 1st and 2nd year of the undergraduate B.Sc. programmes.

- *Advanced Studies*

  These are introductory courses to specialized fields within Information Systems, Applied Computer Science and Software Systems Science corresponding to the 3rd year of the B.Sc. degree and advanced modules in particular research areas which correspond to the 1st and 2nd year of the graduate M.Sc. programmes.

As our guest students you may attend modules at any of these levels. It is your responsibility to judge if your background will be sufficient to participate successfully in the course. Also, whether or not the credits you earn are valid towards your home degree, is not decided by us, but by your home institution.

Keep in mind, however, that graduate level modules normally assume a significant amount of background in the relevant subject area.

Most modules are based on combined lectures and tutorials. Some courses may also involve lab classes, excursions, blended learning and other teaching arrangements. Research groups regularly offer advanced level seminars and project modules on varying research topics. These may have special entry prerequisites.

1.6 Other Information

The International Office provides information on accommodation, living expenses, language courses and many other aspects of student life at Bamberg.

International Office

Mrs. Julia Argikola

Secretary - Foreign Student Affairs

Otto-Friedrich-Universität Bamberg

D-96047 Bamberg, Germany

Kapuzinerstraße 25

Tel: ++49 (0)951-863-1049

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Email: international@uni-bamberg.de

URL: https://www.uni-bamberg.de/international-office/

You are also welcome to contact the International Affairs Representative of the WIAI Faculty (see address page 2).

The Faculty of Social Sciences, Economics and Business Administration's UNICOACH can be found here:

https://www.uni-bamberg.de/en/sowi/studies/studying-internationally/studying-in-bamberg/exchange-studies/

UNICOACH is a series of short videos providing information on important student life issues like *"how to understand the university system"* or *„how to register for classes and exams"*.

2 Introducing the Faculty's Teaching and Research Groups

2.1 Applied Computer Science

AISE – AI Systems Engineering

Prof. Dr. Christoph Benzmüller
Chair of Information Visualization
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Internet: https://www.uni-bamberg.de/aise/

Our research activities are interfacing the areas of artificial intelligence, philosophy, mathematics, computer science, and natural language. Current research focuses on the use of formal argumentation & explanation to achieve trustworthy AI systems, that is reasonable machines. I am particularly interested in the use of classical higher-order logic (HOL) as a universal meta-logic to automate various non-classical logics and to utilise them in topical application areas, including machine ethics & machine law, metaphysics (e.g. Gödel's ontological argument), mathematical foundations (e.g. category theory) and rational argumentation. My research activities also address the integration of automated reasoning, machine learning and agent-based architectures. I have a core expertise in classical higher-order logic (HOL), and I have contributed to its semantics and proof theory, and together with colleagues and students I have developed the Leo theorem provers for HOL.

KogSys – Cognitive Systems

Prof. Dr. Ute Schmid
Head of Cognitive Systems Group
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Internet: http://www.uni-bamberg.de/kogsys

In the research domain Cognitive Systems (CogSys) we are concerned with the development of approaches, concepts, and methods for design, description, construction and analysis of intelligent systems based on cognitive principles. Our research strategy is to combine empirical studies of cognitive phenomena, development of algorithms, and their testing in different areas of application. Main topics of our group are induction and learning as well as planning and problem solving in single- and multi-agent settings. Especially, we are interested in the inductive synthesis of recursive functional programs from incomplete specifications (e.g., input/output examples) which can be seen as a general approach to learning productive rules from experience. Furthermore, we investigate

analogical reasoning as a powerful approach to problem solving as a special mechanism of knowledge acquisition. Application areas are, for example, support of human problem solvers in the domains of software development, classifier learning for medical diagnostics, quality control, decision support or incident mining and assistant systems for activities of daily life.

CG – Computer Graphics

Prof. Dr. Sophie Jörg
Chair of Computer Graphics and its Foundations
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Mail: sophie.joerg@uni-bamberg.de
Internet: https://www.uni-bamberg.de/cg/

Research in the Computer Graphics Group revolves around virtual characters, motion perception, virtual reality and augmented reality, as well as character animation.

KInf – Computing in the Cultural Sciences

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In research and teaching, we focus on computational issues relevant to the cultural sciences. At our laboratory we develop software solutions that assist, for instance, preservation scientists working with built heritage or sociologists studying web-based communication processes. Technologically speaking, our software relies on methods from semantic information processing that we continue to improve. Our key areas of interest are Geoinformation systems and services, Digital libraries and archives, Mobile assistance systems, and Computer-mediated communication.

xAI – Explainable Machine Learning

Prof. Dr. Christian Ledig
Chair of Explainable Machine Learning
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96047 Bamberg
Mail: christian.ledig@uni-bamberg.de
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The research group focuses on the development of robust, data-efficient methods of machine learning with varied applications in the industry and especially in the healthcare sector. The overarching goal is to make a positive contribution to the society, or human wellbeing respectively. You can find a detailed description of our research areas on our website in the section “research focus”. Our teaching activities include courses on Deep Learning and Mathematics for Machine Learning for Master students as well as several Seminars and Projects for Bachelor and Master students. We teach in English and our exams and course material are also in English.

NLproc – Fundamentals of Natural Language Processing

Prof. Dr. Roman Klinger
Chair of Fundamentals of Natural Language Processing
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96050 Bamberg
Mail: roman.klinger@uni-bamberg.de
Internet: https://www.uni-bamberg.de/en/nlproc/

We work on processing natural language in written form, that means, we perform research to enable computers to understand language (natural language understanding) and also to generate language (natural language generation). We cover all steps in this research and development process, including

- Resource Development (we need data that exemplify the phenomena we want to model)
- Modeling (we develop machine learning models, often based on deep learning, probabilistic methods, or large language models), which learn from these data
- Application (we apply the systems we develop across various areas to understand their limitations and help other areas to benefit from the value of such systems)

The BamNLP group focuses on a set of NLP topics:

- Modeling of psychological concepts (emotions, intend, belief, deception, argumentation, persuasion)
- Interdisciplinary research (digital humanities, computational psychology, computational social sciences, corpus linguistics, biomedical NLP)

- Fundamental NLP and machine learning research (deep learning, large language models, probabilistic graphical models)

HCI – Human-Computer Interaction

Prof. Dr. Tom Gross
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Internet: http://www.uni-bamberg.de/hci

Human-Computer Interaction (HCI) aims at optimally supporting users through technology (mainly computer technology) by amplifying their strengths and compensating their weaknesses. The Special Interest Group HCI of the German Informatics Society provides the following definition: “The field of Human-Computer Interaction comprises the analysis, design, and evaluation of human- and task-centred computer applications" (in German). In the context of HCI interactive systems are often mentioned—an interactive (computer-) system thereby is described as a unity consisting of software and hardware that receives input from users and gives immediate feedback. The usability of interactive systems can be evaluated along three factors: effectiveness (accuracy and completeness with which users achieve their goals), efficiency (resources expended by users to achieve these goals), and satisfaction (the users' positive attitudes towards the use of the system).

VIS – Information Visualization

Prof. Dr. Fabian Beck
Chair of Information Visualization
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Mail: fabian.beck@uni-bamberg.de
Internet: https://www.uni-bamberg.de/en/vis/

We envision to help people understand data. We design and implement novel visualizations that support users in effectively analyzing complex data and gain new insights. We offer student theses and projects in the area of information visualization and visual analytics.

MI – Media Informatics

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Chair of Media Informatics
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Mail: andreas.henrich@uni-bamberg.de
Internet: http://www.uni-bamberg.de/minf/

Media Informatics aims at a purposeful application of single media types and multimedia systems in various application areas. It considers aspects like media technique, media design, media storage and retrieval as well as the use of media with a focus on the development of multimedia systems. The main focus of this chair is on media storage and retrieval and the development of domain specific multimedia applications.

MII – Multimodal Intelligent Interaction

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Chair of Multimodal Intelligent Interaction
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Internet: https://www.uni-bamberg.de/mii/

The areas of research at the group include robotics, human-robot interaction, intelligent systems, autonomous handling of complex tasks, and joint action scenarios between humans and robots. An intelligent system must be able to understand and solve complex tasks if it is to interact autonomously with its environment. This poses a number of challenges: unstructured environments require flexible solutions in order to be able to react to external factors. In addition, tasks can usually be solved in different ways and must be adapted to the capabilities of the robot system. Ambiguities in the interaction with users result in unclear instructions that need to be supplemented to be fully understood, e.g., from the context. In addition to the need for anticipating human behavior and supporting a variety of modalities, commonsense and domain knowledge must also be represented. The combination of symbolic and subsymbolic AI in a hybrid approach is central to this. Furthermore, social aspects must also be taken into account in this kind of interaction between robots and humans.

DS – Natural Language Generation and Dialogue Systems

Prof. Dr. Stefan Ultes
Chair of Natural Language Generation and Dialogue Systems
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Gutenbergstraße 13
96047 Bamberg
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Web: https://www.uni-bamberg.de/ds/

The Natural Language Generation and Dialogue Systems Group conducts research within the broad field of Conversational AI and spoken dialogue systems focussing on methods and technology to realise natural voice-first interaction between humans and machines. Employing machine learning methods, the group's research addresses the following questions: which properties and abilities must a system have to act in a natural manner, which factors make the behaviour of the system to be perceived as natural, and how to realise this natural interaction from a technical point of view. In other words, the goal is to understand all factors that constitute “natural system behaviour” in the context of spoken interaction.

UxD – User Experience and Design

Prof. Dr. Patrick Tobias Fischer
Chair of User Experience and Design
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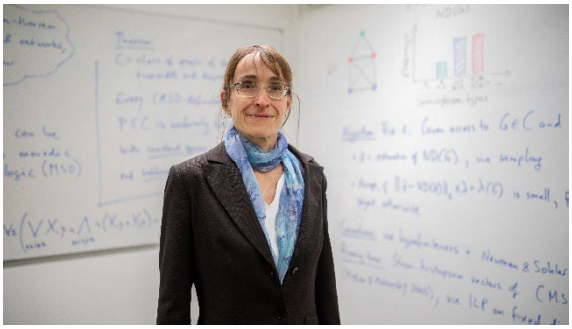
Internet: https://www.uni-bamberg.de/uxd/

At the chair of User Experience and Design our teaching activities center on Urban Interaction Design, Interface Design and Multimodal Experiences. We develop knowledge for and through design. By prototyping novel types of interaction and interfaces we explore experiential and sociopragmatic values, relationships, materiality and behaviour in the context of public life and urban environments. To unlock the students and our creative potential and imagine novel interactive situations, we constantly learn about and engage with a variety of design materials. Sensors, actuators, micropocessors, blue foam, paper, 3D prints, 2- and 3D-graphics, artificial intellicence, behavioural patterns, etc. are just a few to name. Combined with theoretic knowledge from Urban Design, MediaArchitecture and HCI novel ways of user experiences are shaped to discover new knowledge.

2.2 Computer Science

AlgoK – Algorithms and Complexity Theory



Prof. Dr. Isolde Adler
Chair of Algorithms and Complexity Theory
Office 03.28
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Internet: https://www.uni-bamberg.de/algok/

Research at the chair is centred around the design of efficient algorithms (with guarantees) for discrete structures, with a particular interest in the interplay between efficiency and the combinatorial structure of the input instances. For example, many classical problems on graphs are NP-hard in general, but they lie at the core of numerous applications, so they need to be solved in practice. These problems include the famous Graph Colouring Problem, the Hamiltonian Cycle Problem, and many others. However, if we restrict the inputs to trees or "tree-like" graphs, many of these problems become efficiently solvable.

We aim to push the boundaries of efficient solvability, with new algorithms tailored to the structure of the input instances, and complementing the picture by proving lower bounds. We are interested in classical and modern algorithms, such as parameterised algorithms, sublinear time algorithms, and property testing.

Beyond Algorithms and Complexity Theory, our research draws from the areas of Graph Theory, Logic and Combinatorics, Algorithmic Model Theory, and many more.

Our research has applications in a wide range of areas beyond graphs and networks, including database query evaluation, model checking and verification, combinatorial games, compiler construction, and AI.

ESE – Experimental Software Engineering

Prof. Dr. Matthias Galster
Chair of Experimental Software Engineering
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96047 Bamberg
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Internet: http://www.uni-bamberg.de/ese/

More information coming soon.

DT – Data Engineering

Prof. Dr. Maximilian E. Schüle
Data Engineering
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Internet: http://www.uni-bamberg.de/en/dt

The data engineering group at university of Bamberg teaches concepts for database systems including advanced SQL for Master students, systems programming in C++ as introductory course for Bachelor and as advanced course for Master students. Within one seminar per semester for each Bachelor and Master students, we discuss current trends in database research based on conference papers.

GdI – Foundations of Computer Science

Prof. Michael Mendler, PhD (Edinburgh)
Informatics Theory Group
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Internet: http://www.gdi.uni-bamberg.de

The group teaches the foundational aspects of computer science in all degree programmes, such as logic, automata and formal language theory, functional programming and the theory of distributed systems. In our research we are mainly concerned with constructive modal logic and type theory and their applications as well as the semantics of synchronous programming languages.

MOBI – Chair of Mobile Systems

Prof. Dr. Daniela Nicklas
Chair of Information Systems, esp. Mobile Software Systems / Mobility
Office 05.128
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Internet: https://www.uni-bamberg.de/en/mobi/

The MOBI focuses on data management for mobile systems, data stream management/complex event processing and development support for sensor-based applications, in the area of smart cities.

PSI – Privacy and Security in Information Systems Group

Prof. Dr. Dominik Herrmann
Chair of Information Systems and Applied Computer Sciences, esp. Privacy and Security Information Systems
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Mail: dominik.herrmann@uni-bamberg.de
Internet: https://www.uni-bamberg.de/en/psi/

The focus of the PSI Group is the protection of information systems and the protection of privacy with technical mechanisms. To this end, the PSI Group analyzes and evaluates existing systems and develops protective mechanisms. The PSI Group cooperates with working groups in the fields of machine learning (inference attacks, online tracking), law (data protection, law enforcement) and ethics (value-oriented system design).

SWT – Software Technologies Research Group

Prof. Dr. Gerald Lüttgen
Head of Software Technologies Research Group
Office 03.014
An der Weberei 5
96047 Bamberg
Internet: www.uni-bamberg.de/swt/

The Software Technologies Research Group (SWT) specializes in the quality assurance of complex software systems based on model-centric engineering and formal analysis. Specific areas of expertise are software testing, automated verification, program comprehension, concurrency theory, synchronous real-time systems, and intelligent cyber-physical systems. Students enrolling in SWT modules are expected to have a strong interest in software engineering and modelling, be proficient in mathematical and computational thinking, and show a high degree of commitment to learning.

SYSNAP – Systems Programming

Prof. Dr. Michael Engel

Practical Computer Science, esp. Systems Programming

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Internet: https://www.uni-bamberg.de/sysnap/

We are currently in the process of building the group and additional content will follow shortly

2.3 Information Systems

DW – Digital Work

Prof. Dr. Gerit Wagner
Junior Professorship for Digital Work
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Digital technologies drive fundamental change processes and create new possibilities in the organization and design of work. Our goal is to understand these change processes and derive recommendations from them in order to shape a future in which work is not only more productive and intelligent, but also focused on the well-being of employees.

EESYS – Energy Efficient Systems

Prof. Dr. Thorsten Staake
Chair of Information Systems, esp. Energy Efficient Systems
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Internet: http://www.uni-bamberg.de/eesys

The Energy Efficient Systems Group focuses on the development of Information Systems (IS) for supporting and motivating sustainable consumer behavior. Particular consideration is given to smart metering and smart grid infrastructure and the design of related systems that enable energy efficiency services for private households. With a clear focus on the development and assessment of applications that are applicable to the mass market, the group closely works together with both, industry partners and startup companies. The research results build an important cornerstone of the teaching activities at bachelor and master level.

ISHANDS – Health and Society in the Digital Age

Prof. Dr. Christian Maier
Chair of Information Systems, esp. Energy Efficient Systems
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Mail: christian.maier@uni-bamberg.de
Internet: https://www.uni-bamberg.de/en/ishands/

The teaching portfolio of the ISHANDS chair includes Bachelor's and Master's courses, such as Digital Privacy, Digital Change Management, and Digital Health. We provide students with relevant and latest theoretical knowledge and teach them how to use it in practice. Among others, we therefore use real-world case studies and simulations. Our research focuses on digital transformation and its impact on individuals and organizations. Specifically, we study the areas of digital health and well-being (e.g., technostress, burnout, addiction), technology acceptance and use (e.g., morality, privacy), and the future of work (e.g., telework, boomerang hires). We use quantitative and qualitative research methods with different data collection forms, such as interviews, case studies, diaries, (cross-sectional and longitudinal) questionnaires, and experiments.

IIS – Industrial Information Systems

Prof. Dr. Sven Overhage
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Internet: http://www.uni-bamberg.de/iis

The Chair of Industrial Systems focuses on the design and the operation of industrial information systems, which are the backbone of production and commerce businesses. We offer courses for bachelor, master, and PHD students alike. Amongst others, our courses focus on the development and design of application systems, enterprise architecture management, electronic business, intra-organizational systems, and modular and on-demand systems.

ISDL – Information Systems in the Service Industry

Prof. Dr. Tim Weitzel
Chair of Information Systems, esp. Information systems in the service industry
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The four main research areas of the ISS team are (1) Business-IT Alignment and Business Value of IT, (2) (Social) Networks and IT, (3) IT Adoption and Usage and (4) Outsourcing Management. You can find a detailed description of our research projects in the section "for researchers". Our research results have been published in scientific journals and conferences.

ISM – Information Systems Management

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In research and teaching the Chair of ISM deals with questions concerning the management of information systems and technologies as well as with the challenges of digital innovation and transformation. The management of the information systems (IS) of an organization - consisting of those technical and personnel components, which are involved in the production, processing and use of information - is in particular in the 'age of digitization' an elementary component of successful organization management.

AIC – AI Engineering in Companies

Prof. Dr. Milad Mirbabaie
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The Chair of AI Engineering in Companies (AIC) focuses on comprehensive research and teaching related to digital transformation, emphasizing the digital society. Our primary focus is on socio-technical systems that define the interaction between new technologies and people. We are particularly interested in how these interactions affect individuals, society, and businesses. Our key research areas include AI-based systems, digital assistants, digital detox, ethics in AI, crisis communication, crisis management, and social media. We explore how AI can enhance organizational processes, the role of digital assistants and the importance of balancing technology use through digital detox. Ethical considerations in AI, effective crisis communication and management, and the impact of social media are also central to our work. In our teaching, we prepare students to navigate and lead in a digitally transformed world, offering courses and research opportunities in these cutting-edge topics.

ISPL – Information Systems and Digital Platforms

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Our current teaching offer includes courses on the management of digital platforms and the role of digital platforms in industries and society, as well as research seminars. The courses draw on current research insights and cover topics that are highly relevant for individuals, organizations, and policy makers.
In our research, we use qualitative and quantative methods to study digital innovation produced by collectives of organizations and individuals. For example, we study the governance and evolution of digital platforms and ecosystems in different domains, including enterprise software and mobile apps, or collaboration in teams, in particular in the context of software development.

SNA – Social Networks

Prof. Dr. Oliver Posegga
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We dedicate our work to research and education on the role of information systems in social networks and the use of social media (e.g. blogs, wikis) for managing knowledge within and between organizations as well as on digital

transformation. We conduct theoretical and empirical research and collaborate with industry partners in these fields.

GAMES – Information Systems

Prof. Dr. Benedikt Morschheuser
Chair of Information Systems
Office 04.025
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Internet: https://www.uni-bamberg.de/games/

The Gamification Research Group at the Institute of Information Systems at the University of Bamberg investigates the increasing penetration of business, and everyday life with technologies and approaches from the gaming industry (e.g., gamification, virtual & augmented reality, virtual goods, the "Metaverse," exergames, and game-based learning).

3 Module Descriptions

The following appendix titled "Module Handbook – International Studies" describes in detail all modules scheduled to run during 2025-2026.

The module handbook starts with an index of all modules listed by the area of studies. In Section 1 of the list *International Studies taught in English (on demand)* you find all modules that are offered in English either regularly or on demand. In the latter case, since the lecture may be in German if all students are German-speaking, you need to tell the lecturer before the semester if you require English tuition. Modules listed in Section 2 of the list *Exams in English on demand, though course material often in German, may sometimes be available in English* are delivered in German but (again "on demand") are examined in English if requested. To find out more information please consult the detailed module descriptions or contact the module lecturer. Within each Section the modules are organised by subject group (Applied Computer Science, Computer Science, Information Systems) and further by the name of the Teaching and Research Group who are responsible for the offering.

The index of a single module lists its acronym, its title, how many ECTS credit points it comprises, in which semester it is offered and on which page you can find its full description. For example, here is a description of the information related to the module "PSI-IntroSP-B":

1	2	3	4	5
PSI-IntroSP-B	Introduction to Secrurity and Privacy	6,00 ECTS	every winter semester	page number

1. "PSI-IntroSP-B":
    a. "PSI" stands for the research group that provides the module; in this case, this is "PSI - Privacy and Security in Information Systems Group"
    b. "IntroSP" is the short form of the module title; here, this is Introduction to Security and Privacy
    "B" stands for "Bachelor" which means the module is suggested for undergraduate students. The ending "M" indicates the recommendation that the module should be attended by graduate astudents.
    NOTE: International Exchange Students may attend any module offered, at undergraduate or graduate level.
2. "Introduction to Security and Privacy": This is the title of the module
3. "6,00 ECTS": ECTS indicate the workload for the module (see "Sec. 1.4 Workload")
4. The module is offered every winter semester
5. The page on which you find a detailed module description.

Modules

Index by areas of study

1) International studies taught in English (on demand) (Bereich)

Find all courses taught in English (on demand) below. Please note: Lectureres will usally ask in the first session whether it should be held in German or English. It is possible, however, they will conduct their session in German. Please don't be afraid to demand continuing in English.

a) Information Systems (Subject Group)

aa) Projects & Seminars of Information Systems Group (Subject)

Bachelor's Projects & seminars of Information Systems Group are not listed with their exact but with an abstract title in the module handbook (e.g. WI-Seminar-B instead of IIS-Sem-B). There might be some which are taught in English. Please see the chairs' web pages for further information (https://www.uni-bamberg.de/en/wiai/subject-groups/faecher/) or UnivIS (https://univis.uni-bamberg.de/). You will find two different types:

- Seminar for Bachelor's studies (3 ECTS)
- Project for Bachelor's studies (6 ECTS)

bb) AI Engineering in Companies (Subject)

cc) *** MGnew *** (Subject)

dd) Energy Efficient Systems (Subject)

ee) Social Networks (Subject)

ff) Platform economics (Subject)

gg) Information Systems and Services (Subject)

hh) Information Systems Management (Subject)

b) Computer Science (Subject Group)

aa) Projects & Seminars of Computer Science Group (Subject)

Projects & seminars of Computer Science Group are not listed with their exact but with an abstract title in the module handbook (e.g. Inf-Sem-M instead of MOBI-Sem-M). There might be some which are taught in English. Please see the chairs' web pages for further information (https://www.uni-bamberg.de/en/wiai/subject-groups/faecher/) or UnivIS (https://univis.uni-bamberg.de/). You will find four different types:

- Seminar for Bachelor's studies (3 ECTS)
- Project for Bachelor's studies (6 ECTS)
- Seminar for Master's Studies (3 ECTS)
- Project for Master's Studies (6 ECTS)

bb) Data Engineering (Subject)

cc) Algorithms and Complexity Theory (Subject)

dd) Experimental Software Engineering (Subject)

ee) Systems Programming (Subject)

ff) Mobile Software Systems/Mobility (Subject)

gg) Foundations of Computer Science (Subject)

hh) Privacy and Security in Information Systems (Subject)

ii) Software Technologies (Subject)

c) Applied Computer Science (Subject Group)

aa) Projects & Seminars of Applied Computer Science Group (Subject)

Projects & seminars of Applied Computer Science Group are not listed with their exact but with an abstract title in the module handbook (e.g. AI-Seminar1-B instead of KogSys-Sem-B). There might be some which are taught in English. Please see the chairs' web pages for further information (https://www.uni-bamberg.de/en/wiai/subject-groups/faecher/) or UnivIS (https://univis.uni-bamberg.de/). You will find five different types:

- Seminar for Bachelor's studies (3 ECTS)
- Project for Bachelor's studies (6 ECTS)
- Seminar for Master's Studies (3 ECTS)
- Project for Master's Studies (small, 6 ECTS)
- Project for Master's Studies (large, 15 ECTS)

bb) Fundamentals of Natural Language Processing (Subject)

cc) Explainable Machine Learning (Subject)

dd) AI Systems Engineering (Subject)

ee) Information Visualization (Subject)

ff) Computer Graphics and its Foundations (Subject)

gg) Human-Computer Interaction (Subject)

hh) Natural Language Generation and Dialogue Systems (Subject)

2) Course language German, exams in English on demand, course material may be available in English (Bereich)

Find all courses taught in German with course material available and exam held in English on demand below. Please notify the lecturer you need the course material/exam in English!

a) Applied Computer Science (Subject Group)

aa) Cognitive Systems (Subject)

b) Information Systems (Subject Group)

Module AI-6Proj1-M Project 1 in the subject area Applied Computer Science *Projekt 1 in der Fächergruppe Angewandte Informatik*	6 ECTS / 180 h

(since SS25)
Person responsible for module: Prof. Dr. Tom Gross
further responsible : Professorinnen und Professoren der Angewandten Informatik

Contents:
Fortgeschrittene praktische Bearbeitung einer forschungsrelevanten Aufgabenstellung aus dem gewählten Fachgebiet mit wissenschaftlichen Methoden. Aufbauend auf den in den Vorlesungen und Übungen erworbenen Kenntnissen und Fertigkeiten wird ein kleineres Projekt mit wissenschaftlichem Bezug in einer Gruppe umgesetzt.

Learning outcomes:
Es werden die Fähigkeiten im Bereich der Systementwicklung ebenso weiterentwickelt wie die Kompetenzen in der Projektdurchführung und in der Gruppenarbeit. Das Masterprojekt unterscheidet sich dabei von der Projektarbeit im Bachelorstudiengang durch die Komplexität der Aufgabe und den direkten Bezug zu aktuellen wissenschaftlichen Arbeiten des jeweiligen Lehrstuhls.

Remark:
Der Arbeitsaufwand für dieses Modul gliedert sich in folgende Bereiche:

- Teilnahme an einführenden Präsenzveranstaltungen
- Teilnahme an Gruppenbesprechungen
- Bearbeitung der Projektaufgabenstellung allein und im Team
- Vorbereitung von Projektbesprechungen und -präsentationen
- Prüfungsvorbereitung

Die Aufwände können dabei in Abhängigkeit von der Aufgabenstellung und der in der Gruppe abgestimmten Aufgabenverteilung unter den Gruppenmitgliedern unterschiedlich auf die Bereiche verteilt sein.

prerequisites for the module:
none

Recommended prior knowledge: Empfohlene Vorkenntnisse werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben.	**Admission requirements:** none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Projekt 1 der Fächergruppe Angewandte Informatik **Mode of Delivery:** **Language:** German/English **Frequency:** every semester	**4,00 Weekly Contact Hours**
Learning outcome:	

Es werden die Fähigkeiten im Bereich der Systementwicklung ebenso weiterentwickelt wie die Kompetenzen in der Projektdurchführung und in der Gruppenarbeit. **Contents:** Die genauen Inhalte der Masterprojekte werden vom anbietenden Fachgebiet festgelegt und bekannt gegeben. **Literature:** Die Literatur wird zu Beginn des Semesters vom anbietenden Fachgebiet festgelegt und bekannt gegeben.	

Examination Coursework Assignment and Colloquium **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung. **Description:** Dokumentation des Systems und des Entwicklungsprozesses sowie Kolloquium zum System und zum Entwicklungsprozess. Die Bearbeitungsfrist der Hausarbeit und die Prüfungsdauer des Kolloquiums werden zu Beginn des Semesters bekanntgegeben.	

Module AI-Proj1-M Project 1 in Applied Computer Science *Projektpraktikum 1 zur Angewandten Informatik*	15 ECTS / 450 h 90 h Präsenzzeit 360 h Selbststudium
(since WS16/17) Person responsible for module: Prof. Dr. Tom Gross further responsible : Professorinnen und Professoren der Angewandten Informatik	
Contents: Fortgeschrittene praktische Bearbeitung einer forschungsrelevanten Aufgabenstellung aus dem gewählten Fachgebiet mit wissenschaftlichen Methoden. Aufbauend auf den in den Vorlesungen und Übungen erworbenen Kenntnissen und Fertigkeiten wird in diesem Praktikum ein Projekt mit wissenschaftlichem Bezug in einer Gruppe umgesetzt.	
Learning outcomes: Es werden die Fähigkeiten im Bereich der Systementwicklung ebenso weiterentwickelt wie die Kompetenzen in der Projektdurchführung und in der Gruppenarbeit. Das Praktikum unterscheidet sich dabei von der Projektarbeit im Bachelorstudiengang durch die Komplexität der Aufgabe und den direkten Bezug zu aktuellen wissenschaftlichen Arbeiten des jeweiligen Lehrstuhls.	
Remark: Der Arbeitsaufwand für dieses Modul gliedert sich in folgende Bereiche: • Teilnahme an einführenden Präsenzveranstaltungen • Teilnahme an Gruppenbesprechungen • Bearbeitung der Projektaufgabenstellung allein und im Team • Vorbereitung von Projektbesprechungen und -präsentationen • Prüfungsvorbereitung Die Aufwände können dabei in Abhängigkeit von der Aufgabenstellung und der in der Gruppe abgestimmten Aufgabenverteilung unter den Gruppenmitgliedern unterschiedlich auf die Bereiche verteilt sein.	
prerequisites for the module: none	
Recommended prior knowledge: Empfohlene Vorkenntnisse werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben.	**Admission requirements:** none
Frequency: every semester / **Recommended semester:** / **Minimal Duration of the Module:** 1 Semester	

Module Units	
Projektpraktikum 1 zur Angewandten Informatik **Mode of Delivery:** Practicals **Language:** German/English **Frequency:** every semester	**6,00 Weekly Contact Hours**
Learning outcome: Es werden die Fähigkeiten im Bereich der Systementwicklung ebenso weiterentwickelt wie die Kompetenzen in der Projektdurchführung, im wissenschaftlichen Arbeiten und in der Gruppenarbeit.	

Contents:
Im Praktikum werden wechselnde Projektthemen zu den Inhalten der Lehrveranstaltungen bearbeitet. Dabei sind im Regelfall Aspekte mehrerer Lehrveranstaltungen relevant, so dass sich Teams mit Studierenden, die unterschiedliche Lehrveranstaltungen besucht haben, gut ergänzen. Die in einem Projektpraktikum bearbeitete Aufgabenstellung geht deutlich über den Umfang einer normalen Übungsaufgabe hinaus und wird in Gruppen bearbeitet. Das erarbeitete Ergebnis wird dokumentiert und in einer Abschlusspräsentation vorgestellt.

Die genauen Inhalte der Masterprojekte werden vom anbietenden Fachgebiet festgelegt und bekannt gegeben.

Literature:
Die Literatur wird zu Beginn des Semesters vom anbietenden Fachgebiet festgelegt und bekannt gegeben.

Examination
Coursework Assignment and Colloquium
prerequisites for module examination:
Regelmäßige Teilnahme an der Lehrveranstaltung.
Description:
Dokumentation des Systems und des Entwicklungsprozesses sowie Kolloquium zum System und zum Entwicklungsprozess.

Die Bearbeitungsfrist der Hausarbeit, die Prüfungsdauer des Kolloquiums sowie die Prüfungssprache werden zu Beginn des Semesters bekanntgegeben.

Module AI-Projekt1-B Bachelor Project 1 in Applied Computer Science *Bachelorprojekt 1 der Fächergruppe Angewandte Informatik*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS25/26) Person responsible for module: Prof. Dr. Andreas Henrich further responsible : (qua Amt der bzw. die Studiengangsbeauftragte für den Bachelorstudiengang Angewandte Informatik)	
Contents: Das Modul behandelt die praktische Anwendung grundlegender Methoden aus dem Bereich der Angewandten Informatik im Rahmen eines Projektes. Die behandelten Problemstellungen stammen aus den typischen Anwendungsfeldern der Angewandten Informatik.	
Learning outcomes: I.d.R aufbauend auf den in den Vorlesungen und Übungen des jeweiligen Faches erworbenen Kenntnissen und Fertigkeiten wird im Projekt eine Forschungs- und/oder Entwicklungsaufgabe mit wissenschaftlichem Bezug in einer Gruppe bearbeitet. Dabei werden die Fähigkeiten im Bereich der Systemanalyse und -entwicklung ebenso weiterentwickelt wie die Kompetenzen in der Projektdurchführung und in der Gruppenarbeit.	
Remark: Es ist ein Bachelorprojekt aus einem der Fachgebiete der Angewandten Informatik zu wählen. Die wählbaren Projekte sind in UnivIS über das Schlagwort "AI-Projekt" auffindbar und als Projekte für Bachelorstudierende ausgewiesen.	
prerequisites for the module: none	
Recommended prior knowledge: Empfohlene Vorkenntnisse werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben. In der Regel sollten zuvor bereits andere Module aus dem Fachgebiet belegt worden sein.	**Admission requirements:** none
Frequency: every semester / **Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelorprojekt 1 **Mode of Delivery:** **Language:** German/English **Frequency:** every semester	**4,00 Weekly Contact Hours**
Learning outcome: wie beim Modul beschrieben	
Contents: Die Inhalte der Bachelorprojekte werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben.	
Literature: Die Literatur wird zu Beginn eines Projekts von jedem anbietenden Fachgebiet bekannt gegeben.	

Examination Coursework Assignment and Colloquium **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Als Prüfungsleistung ist eine Hausarbeit sowie ein Kolloquium zu erbringen. Die Bearbeitungsfrist der Hausarbeit und die Prüfungsdauer des Kolloquiums werden von der Betreuerin bzw. dem Betreuer des Projekts zu Beginn der Lehrveranstaltung bekannt gegeben.	

Module AI-Sem1-M Master Seminar Applied Computer Science *Masterseminar in Angewandter Informatik*	3 ECTS / 90 h
(since SS25) Person responsible for module: Prof. Dr. Tom Gross further responsible : Professorinnen und Professoren der Angewandten Informatik	
Contents: Fortgeschrittene aktive wissenschaftliche Bearbeitung aktueller Konzepte, Technologien und Werkzeuge des jeweiligen Fachgebiets.	
Learning outcomes: Ziel ist das Erlernen des eigenständigen Erarbeitens und Präsentierens von Themen des jeweiligen Fachgebiets auf Basis der Literatur. Dabei werden die Fähigkeiten im Bereich der kritischen und systematischen Literaturbetrachtung ebenso weiterentwickelt wie die Entwicklung einer eigenen Perspektive und deren Präsentation.	
Remark: Es ist ein Masterseminar aus einem der Fachgebiete der Angewandten Informatik zu wählen. Die wählbaren Seminare sind in UnivIS über das Schlagwort "AI-Sem" auffindbar und als Seminare für Masterstudierende ausgewiesen.	
prerequisites for the module: keine	

Recommended prior knowledge: Empfohlene Voraussetzungen werden von jedem anbietenden Lehrstuhl festgelegt und bekannt gegeben. In der Regel sollten zuvor bereits andere Module aus dem Fachgebiet belegt worden sein.		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Masterseminar 1 aus der Fächergruppe Angewandte Informatik **Mode of Delivery:** Seminar **Language:** German/English **Frequency:** every semester	**2,00 Weekly Contact Hours**
Contents: Im Seminar werden Fragestellungen zu aktuellen Konzepten, Technologien und Werkzeugen des jeweiligen Fachgebiets behandelt.	
Literature: Die Literatur wird zu Beginn eines Seminars von jedem anbietenden Lehrstuhl bekannt gegeben.	

Examination Coursework Assignment with presentation **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung	

Description: Als Prüfungsleistung ist eine Hausarbeit sowie ein Referat zu erbringen. Alternativ kann die Prüfungsleistung auf Hausarbeit mit Kolloquium festgelegt werden. Die Bearbeitungsfrist der Hausarbeit und die Prüfungsdauer des Referats bzw. des Kolloquiums werden zu Beginn einer jeden Lehrveranstaltung von der Seminarleiterin bzw. dem Seminarleiter bekannt gegeben.	

Module AI-Seminar1-B Bachelor Seminar 1 in Applied Computer Science *Bachelorseminar 1 der Fächergruppe Angewandte Informatik*	3 ECTS / 90 h 23 h Präsenzzeit 68 h Selbststudium
(since SS25) Person responsible for module: Prof. Dr. Andreas Henrich further responsible : (qua Amt der bzw. die Studiengangsbeauftragte für den Bachelorstudiengang Angewandte Informatik)	
Contents: Eigenständige Erarbeitung und Präsentation eines Themas aus dem gewählten Fachgebiet der Angewandten Informatik mit wissenschaftlichen Methoden.	
Learning outcomes: Kompetenzerwerb in den Bereichen kritische und systematische Literaturanalyse, Strukturierung komplexer Sachverhalte, bewertender Vergleich konkurrierender Ansätze. Professionelle Präsentation von Fachthemen. Erlernen des Verfassens wissenschaftlicher Arbeiten.	
Remark: Es ist ein Bachelorseminar aus einem der Fachgebiete der Angewandten Informatik zu wählen. Die wählbaren Seminare sind in UnivIS über das Schlagwort "AI-Seminar" auffindbar und als Seminare für Bachelorstudierende ausgewiesen.	
prerequisites for the module: none	
Recommended prior knowledge: Empfohlene Vorkenntnisse werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben. In der Regel sollten zuvor bereits andere Module aus dem Fachgebiet belegt worden sein.	**Admission requirements:** none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelorseminar 1 **Mode of Delivery:** Seminar **Language:** German/English **Frequency:** every semester	**2,00 Weekly Contact Hours**
Learning outcome: wie beim Modul beschrieben	
Contents: Die Inhalte der Bachelorseminare werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben.	
Literature: Die Literatur wird zu Beginn eines Seminars von jedem anbietenden Fachgebiet bekannt gegeben.	

Examination	

Coursework Assignment with presentation **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Als Prüfungsleistung ist eine Hausarbeit sowie ein Referat zu erbringen. Alternativ kann die Prüfungsleistung auf Hausarbeit mit Kolloquium festgelegt werden. Die Bearbeitungsfrist der Hausarbeit und die Prüfungsdauer des Referats bzw. des Kolloquiums werden zu Beginn einer jeden Lehrveranstaltung von der Seminarleiterin bzw. dem Seminarleiter bekannt gegeben.	

Module AIC-HYIN-M Hybrid Intelligence *Hybrid Intelligence*	6 ECTS / 180 h
(since SS25) Person responsible for module: Prof. Dr. Milad Mirbabaie	
Contents: This module deepens the theoretical, conceptual, and practical foundations of Hybrid Intelligence. Students acquire comprehensive knowledge about integrating artificial and human intelligence in Hybrid Intelligence systems. Hybrid Intelligence aims to combine human and machine strengths by integrating human capabilities such as creativity, emotional intelligence, or contextual understanding with the computational capabilities of AI, such as data analytics or pattern recognition. This module focuses on theoretical concepts, methodological approaches, and practical applications of Hybrid Intelligence.	
Learning outcomes: The aim of the module is to provide students with in-depth knowledge and skills in the field of Hybrid Intelligence. After completing the module, students should be able to comprehensively understand relevant literature in relation to the interaction between humans and machines in order to be able to analyze and critically evaluate the concept of Hybrid Intelligence.	
Remark: The workload for this module is roughly broken down as follows: • Participation in the input sessions on the basics of Hybrid Intelligence • Self-study and preparation of paper presentations in individual or group work • Completion of in-depth assignments in individual or group work • Preparation of a term paper	
prerequisites for the module: None	

Recommended prior knowledge: None		**Admission requirements:** Successful participation in the exercises.
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Hybrid Intelligence **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Milad Mirbabaie **Language:** English **Frequency:** every summer semester	**4,00 Weekly Contact Hours**
Learning outcome: The aim of the module is to provide students with in-depth knowledge and skills in the field of Hybrid Intelligence. After completing the module, students should be able to comprehensively understand relevant literature in relation to the interaction between humans and machines in order to be able to analyze and critically evaluate the concept of Hybrid Intelligence.	

Contents: This module deepens the theoretical, conceptual, and practical foundations of Hybrid Intelligence. Students acquire comprehensive knowledge about integrating artificial and human intelligence in Hybrid Intelligence systems. Hybrid Intelligence aims to combine human and machine strengths by integrating human capabilities such as creativity, emotional intelligence, or contextual understanding with the computational capabilities of AI, such as data analytics or pattern recognition. This module focuses on theoretical concepts, methodological approaches, and practical applications of Hybrid Intelligence.	
Examination Coursework Assignment and Colloquium / Duration of Examination: 60 minutes Duration of Coursework: 3 months	

Module AIC-SPRO-M Research Project: Digital Society and AI-based Systems *Forschungsprojekt Digital Society and AI-based Systems*	6 ECTS / 180 h
(since SS25) Person responsible for module: Prof. Dr. Milad Mirbabaie	
Contents: The course deals with the future of society and the use of artificial intelligence and assistance systems. Relevant topics are explored and reflected on the basis of empirical and theoretical work. The focus is on the question of how society deals with new technologies and the resulting opportunities and risks. Current scientific and socially relevant topics are explained and developments critically reflected on the basis of empirical and theoretical literature.	
Learning outcomes: Students will be able to classify important areas of influence of the digital transformation with a view to society. In addition to the technological and conceptual foundations, ethical aspects are also known and included in the assessment. Students understand the interdisciplinary nature of research and practice, especially with regard to the change in the social status quo through digital technologies, such as artificial intelligence/assistance systems. Students will be able to assess the overall role of digital technologies in the social context. They are familiar with common methods and technologies and can apply them prototypically. They are familiar with the ethical implications and challenges posed by new technologies and are able to interpret and critically classify empirical and theoretical work in this context. A further qualification feature is that the content covered can be applied to their own questions. To this end, relevant research questions and research gaps can be identified.	
prerequisites for the module: None	

Recommended prior knowledge: Previous knowledge of research methods is helpful.		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Forschungsprojekt Digital Society and AI-based Systems **Mode of Delivery:** **Lecturers:** Prof. Dr. Milad Mirbabaie **Language:** English **Frequency:** every summer semester	**4,00 Weekly Contact Hours**
Learning outcome: Students demonstrate the ability to understand key areas of influence of the digital transformation in relation to society. In addition to an understanding of the technological and conceptual foundations, they are also familiar with ethical aspects, which they include in their assessments. Students recognize the interdisciplinary nature of research and practice, especially with regard to the change in the social status quo through digital technologies such as artificial intelligence and assistance systems.	

In addition, students are able to make a comprehensive assessment of the role digital technologies play in the social context. They are familiar with common methods and technologies and can apply them in prototypical form. They are also aware of the ethical implications and challenges associated with new technologies. They are able to interpret and critically analyze empirical and theoretical work in this context. A further qualification feature is their ability to apply the content covered to their own questions by identifying relevant research questions and gaps. **Contents:** The course deals with the future of society and the use of artificial intelligence and assistance systems. Relevant topics are explored and reflected on the basis of empirical and theoretical work. The focus is on the question of how society deals with new technologies and the resulting opportunities and risks. Current scientific and socially relevant topics are explained and developments critically reflected on the basis of empirical and theoretical literature. **Literature:** Further information will be provided in the course.	
Examination Coursework Assignment and Colloquium / Duration of Examination: 60 minutes Duration of Coursework: 3 months	

Module AISE-ETH Ethics and Epistemology of AI *Ethics and Epistemology of AI*	6 ECTS / 180 h
(since SS22) Person responsible for module: Prof. Dr. Christoph Benzmüller	
Contents: This course takes an innovative and experimental approach to ethics with an interdisciplinary focus enabled by collaboration between the Computer Science, Engineering Science and Philosophy of Technology departments. It involves engaging with the theoretical and practical approaches that address the intersection of ethics and technology, in this case AI.	
Learning outcomes: Students will learn to critically assess the relationship between technology and society and to analyze the interactions between technology and society from an ethical perspective. Furthermore, students will deal with the deconstruction of the concept of neutrality of technology and learn to critically assess it. At the same time, the environment will be taken as a stakeholder in its own right in order to consider the impact of technological applications from a sustainability perspective. The module will provide students with the necessary theoretical foundations stemming from both computer science (in particular AI and digital technologies) and ethics. This knowledge will be put into practice and deepened through case-based projects carried out in interdisciplinary groups. The projects will address the current challenges encountered through the use of AI technologies in different fields of application (e.g., medical, financial, social etc.), as well as discuss different implementations and possible avenues of research that could enable the development of ethically acceptable AI systems. Students will prepare a presentation of their project as well as a scientific poster.	
Remark: The main language of instruction in this course is English. The course is held in collaboration with TU Berlin (group of Prof. Dr. Sabine Ammon)	
prerequisites for the module: keine	

Recommended prior knowledge: Basic knowledge in AI, philosophy or computational humanities.		**Admission requirements:** keine
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture Ethics and Epistemology of AI **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Christoph Benzmüller **Language:** English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Learning outcome: Students will learn to critically assess the relationship between technology and society and to analyze the interactions between technology and society from an ethical perspective. Furthermore, students will deal with the deconstruction of the concept of neutrality of technology and learn to critically assess it. At the same time, the environment will be taken as a stakeholder in its own right in	

order to consider the impact of technological applications from a sustainability perspective.

The module will provide students with the necessary theoretical foundations stemming from both computer science (in particular AI and digital technologies) and ethics. This knowledge will be put into practice and deepened through case-based projects carried out in interdisciplinary groups. The projects will address the current challenges encountered through the use of AI technologies in different fields of application (e.g., medical, financial, social etc.), as well as discuss different implementations and possible avenues of research that could enable the development of ethically acceptable AI systems. Students will prepare a presentation of their project as well as a scientific poster.

Contents:
This course takes an innovative and experimental approach to ethics with an interdisciplinary focus enabled by collaboration between the Computer Science, Engineering Science and Philosophy of Technology departments. It involves engaging with the theoretical and practical approaches that address the intersection of ethics and technology, in this case AI.

Literature:
selected research papers are announced in lecture course

2. Lecture Ethics and Epistemology of AI
Mode of Delivery: Practicals
Lecturers: Prof. Dr. Christoph Benzmüller
Language: English
Frequency: every summer semester

2,00 Weekly Contact Hours

Learning outcome:
Students will learn to critically assess the relationship between technology and society and to analyze the interactions between technology and society from an ethical perspective. Furthermore, students will deal with the deconstruction of the concept of neutrality of technology and learn to critically assess it. At the same time, the environment will be taken as a stakeholder in its own right in order to consider the impact of technological applications from a sustainability perspective.

The module will provide students with the necessary theoretical foundations stemming from both computer science (in particular AI and digital technologies) and ethics. This knowledge will be put into practice and deepened through case-based projects carried out in interdisciplinary groups. The projects will address the current challenges encountered through the use of AI technologies in different fields of application (e.g., medical, financial, social etc.), as well as discuss different implementations and possible avenues of research that could enable the development of ethically acceptable AI systems. Students will prepare a presentation of their project as well as a scientific poster.

Contents:
This course takes an innovative and experimental approach to ethics with an interdisciplinary focus enabled by collaboration between the Computer Science, Engineering Science and Philosophy of Technology departments. It

involves engaging with the theoretical and practical approaches that address the intersection of ethics and technology, in this case AI. **Literature:** selected research papers are announced in lecture course	

Examination Portfolio **Description:** The module examination consists of five parts: • Text-Mind-Map (15%): Reading and presentation of a text + summary of contents through a mind-map (1 page) • Debate Moderation (10%): Moderation of a debate • Interim Presentation (15%): Presentation (with slides) of interim results and future work planned to achieve the project • Final Presentation (25%): 20 min Presentation (with slides/poster) + 20 min Q&A • Final Deliverable (35%): Depending on the project, can take the form of a short guide, website, computer program, or audio/video material + documentation of the project	

Module AISE-FTAIP-B Frontier Topics in AI and Philosophy *Frontier Topics in AI and Philosophy*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Christoph Benzmüller	

Contents:

The course explores state-of-the-art topics at the frontier between philosophy and Artificial Intelligence, including:

A. Introduction to AI and Philosophy: This is an overview of fundamental concepts in artificial intelligence and the philosophical questions that have accompanied its development. This includes e.g. questions about the extent and limits of considering human thought computable.

B. Critical Reflections on Ethics and AI: This topic refers to the critical examination of current ethical considerations inherent in the design, development, and deployment of AI systems. The focus is on challenging and questioning current investigations on XAI, transparency of AI, algorithmic bias, and the responsibility of AI developers towards society.

C. Consciousness and Artificial Minds: This relates to the research program connecting artificial and human neural structures. It includes not only current parallelism between AI and neuroscience (e.g. the understanding of human brain models as vector space), but also what AI advancements can tell us about consciousness and the mind. Discussions could also cover the possibility of machine consciousness and the issue of machine creativity.

D. Philosophy of Information: This topic delves into the philosophy of information as it relates to AI, including the relationship between entropy and information, the ontology of information, the ethics of information, and how AI reshapes these philosophical issues.

E. AI, Society, and the Future: This includes the analysis of the broader societal impacts of AI, such as privacy, surveillance, labor rights, and the future of human-machine coexistence. This also includes specific case studies such as AI in healthcare, autonomous vehicles, natural language processing, etc.

All in all, the course aims at bringing together insights from Ai research and philosophy to foster a holistic understanding of AI's multifaceted impact on modern life and future directions in human cognition and social organization.

Learning outcomes:

For computer science students attending the course “Frontier Topics in AI and Philosophy,” the learning objectives are designed to bridge the gap between technical AI competencies and philosophical understanding, fostering a comprehensive, interdisciplinary skill set. Here are the key learning objectives and skills:

1. Understanding of AI Foundations and Philosophical Implications: Students will gain a solid grounding in the fundamental concepts of artificial intelligence, alongside an understanding of the philosophical questions that accompany AI's development.

2. Critical Analysis: Students will develop the ability to critically examine the ethical considerations in AI's design, development, and deployment.

3. Multidisciplinary Insights: Students will acquire knowledge on the intersections between AI and the philosophical approach to neuroscience and human cognition concerning consciousness and understanding between human and machine.

4. Societal impact: As potential future handler and programmer of AI systems, the course students will learn to understand the broader societal impacts of AI systems, with focuses on the evaluation of specific case studies to understand the practical applications and ethical dilemmas of AI technologies.

5. Critical Thinking and Innovation: Students will acquire a holistic understanding of AI's multifaceted impact on modern life, human cognition, and social organization. Students will be encouraged to think beyond conventional boundaries to cultivate a well-rounded perspective on AI's role in society and future directions.

6. Interdisciplinary Communication: In light of the interdisciplinary nature of AI research, students will acquire effective communication skills that enable the articulation of complex ideas and debates in AI to diverse audiences, including technical and non-technical stakeholders.

prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Frontier Topics in AI and Philosophy **Mode of Delivery:** Lectures **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Learning outcome: Students will be introduced to the fundamentals of formal languages, from basic principles to more advanced applications. This includes propositional logic, first order logic, modal logic, and lambda calculus (in the tutorials). Learning the syntax and semantics of such formal languages is crucial for understanding the computational processes and algorithms that underpin computer science.	

The course also illuminates the philosophical aspects and challenges associated with formal languages. This includes questions about the limits of formal languages (undecidability, incompleteness), the impact of this limit on the computability of human thinking, semantic paradoxes, and their resolution. Engaging with these conceptual foundations and implications of formal languages encourages critical thinking and a deeper understanding of the theoretical underpinnings of computer science. Beyond theoretical knowledge, the course emphasizes the practical application of formal languages. Students are expected to develop the ability to utilize formal languages in relevant contexts, recognizing their potential for automation and data processing. This skill set is essential for the development, analysis, and optimization of algorithms and software.	
Contents: This lecture offers an accessible, step-by-step introduction to formal languages, requiring no prior knowledge or prerequisites. It is designed to equip students with fundamental skills in formal languages as well as an understanding of their role in philosophy, computer science, and linguistics. Formal languages are crucial to the efficient and precise communication of information, offering agility and clarity that surpass natural language, and allowing for information automation in computer. This makes the mastery of formal languages not just an intellectual pursuit but an important practical skill for future working philosophers, computer scientists, and linguists. In addition, formal languages are at the center of some of the most puzzling philosophical questions, for example about the limits of cognition, semantic paradoxes, or the existence of abstract objects. Complementing the lecture is the seminar Language and Beyond: Philosophy, Computer Science, Linguistics; it provides reading materials, exercises, and examples on the topics of the course. The seminar is optional, but recommended.	
Examination Written examination / Duration of Examination: 90 minutes	

Module Units	
Introduction to Formal Languages: Applications and Philosophical Questions **Mode of Delivery:** Practicals **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Learning outcome: Students will be introduced to the fundamentals of formal languages, from basic principles to more advanced applications. This includes propositional logic, first order logic, modal logic, and lambda calculus (in the tutorials). Learning the	

syntax and semantics of such formal languages is crucial for understanding the computational processes and algorithms that underpin computer science. The course also illuminates the philosophical aspects and challenges associated with formal languages. This includes questions about the limits of formal languages (undecidability, incompleteness), the impact of this limit on the computability of human thinking, semantic paradoxes, and their resolution. Engaging with these conceptual foundations and implications of formal languages encourages critical thinking and a deeper understanding of the theoretical underpinnings of computer science. Beyond theoretical knowledge, the course emphasizes the practical application of formal languages. Students are expected to develop the ability to utilize formal languages in relevant contexts, recognizing their potential for automation and data processing. This skill set is essential for the development, analysis, and optimization of algorithms and software. **Contents:** Exercises complementing the lecture content as described above.	

Module AISE-PLM-V Computational Metaphysics - Mechanizing Principia Logico-Metaphysica *Computational Metaphysics - Mechanizing Principia Logico-Metaphysica*		3 ECTS / 90 h
(since SS23) Person responsible for module: Prof. Dr. Christoph Benzmüller further responsible : Kirchner, Daniel, Dr.; Vestrucci, Andrea, Prof. Dr.		
Contents: In this lecture course we will study foundational theories in metaphysics (with a focus on Edward Zalta's Principia Logico-Metaphysica) and discuss/explore their mechanisation and assessment with modern proof assistant systems.		
Learning outcomes: Acquisition of basic knowledge on the foundations of metaphysics, and acqusition of basic knowledge on the mechanisation of such theories in modern proof assistant systems.		
Remark: Will be offered (ideally yearly) as block course in collaboration with Edward Zalta, PhD, Stanford University		
prerequisites for the module: none		
Recommended prior knowledge: Grundlagenkenntnisse in Logik und Metaphysik sind empfohlen.		**Admission requirements:** none
Frequency: annually	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Computational Metaphysics - Mechanizing Principia Logico-Metaphysica **Mode of Delivery:** Lectures **Language:** English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Learning outcome: Acquisition of basic knowledge on the foundations of metaphysics, and acqusition of basic knowledge on the mechanisation of such theories in modern proof assistant systems.	
Contents: In this lecture course we will study foundational theories in metaphysics (with a focus on Edward Zalta's Principia Logico-Metaphysica) and discuss/explore their mechanisation and assessment with modern proof assistant systems.	
Literature: E. N. Zalta. *Abstract Objects: An Introduction to Axiomatic Metaphysics*. D. Reidel, 1983. ISBN: 9789027714749. E. N. Zalta. *Intensional Logic and the Metaphysics of Intentionality*. MIT Press, 1988. ISBN: 9780262240277. E. N. Zalta. Principia Logico-Metaphysica. https:/ /mally.stanford.edu / principia.pdf. [accessed: January 30, 2023].	

E. N. Zalta. The Theory of Abstract Objects. https://mally.stanford.edu/theory.html. [accessed: January 30, 2023].

D. Kirchner. “Abstract Object Theory”. In: *Archive of Formal Proofs* (Nov. 2022). https://isa-afp.org/entries/AOT. html, Formal proof development. ISSN: 2150-914x.

D. Kirchner. “Computer-Verified Foundations of Metaphysics and an Ontology of Natural Numbers in Isabelle/HOL”. PhD thesis, FU Berlin, 2022. https://refubium.fu-berlin.de/handle/fub188/35426

D. Kirchner, C. Benzmüller, and E. N. Zalta. “Computer Science and Metaphysics: A Cross-Fertilization”. In: *Open Philosophy* 2.1 (2019). Ed. by P. Grim, pp. 230–251. DOI: 10.1515/opphil-2019-0015.

D. Kirchner, C. Benzmüller, and E. N. Zalta. “Mechanizing Principia Logico-Metaphysica in Functional Type Theory”. In: *Review of Symbolic Logic* 13.1 (2020), pp. 206–218. DOI: 10.1017/S1755020319000297.

Examination
Oral examination / Duration of Examination: 30 minutes

Module AISE-UL Universal Logic & Universal Reasoning *Universelle Logik & Universelles Schließen*	6 ECTS / 180 h
(since WS22/23) Person responsible for module: Prof. Dr. Christoph Benzmüller	
Contents: Knowledge representation and reasoning applications in computer science, AI, philosophy and math typically employ very different logic formalisms. Instead of a "single logic that serves it all" (as envisioned already by Leibniz) an entire "logic zoo" has been developed, in particular, during the last century. Logics in this zoo, e.g., include modal logics, conditional logics, deontic logics, multi-valued logics, temporal logics, dynamic logics, hybrid logics, etc. In this lecture course we will introduce, discuss and apply a meta logical approach to universal logical reasoning that addresses this logical pluralism. The core message is this: While it might not be possible to come up with a universal object logic as envisioned by Leibniz, it might in fact be possible to have a universal meta logic in which we can semantically model, analyse and apply various species from the logic zoo. Classical higher order logic (HOL) appears particularly suited to serve as such a universal meta logic, and existing reasoning tools for HOL can fruitfully be reused and applied in this context.	
Learning outcomes: The participants of this course will, in combination with a hands-on introduction to Isabelle/HOL, learn about HOL, about semantical embeddings (SSE technique) of non-classical logics in HOL, and about proof automation of these logics in Isabelle/HOL. They will conduct practical exercises regarding the application of the SSE technique in philosophy, mathematics or artificial intelligence, including, normative reasoning and machine ethics.	
Remark: The main language of instruction in this course is English. The overall workload of 180h for this module consists of: • weekly classes: 22h • tutorials: 8h • Work on assignment: 90h • Literature study 40h • preparation for and time of the final exam: 20h	
prerequisites for the module: none	
Recommended prior knowledge: Basic knowledge about classical and non-classical logics, theoretical computer science.	**Admission requirements:** non

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester Semester

Module Units	
AISE-UL: Universal Logic & Universal Reasoning (Universelle Logik & Universelles Schließen) **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Christoph Benzmüller	**2,00 Weekly Contact Hours**

Language: English
Frequency: every winter semester

Learning outcome:
The participants of this course will, in combination with a hands-on introduction to Isabelle/HOL, learn about HOL, about semantical embeddings (SSE technique) of non-classical logics in HOL, and about proof automation of these logics in Isabelle/HOL. They will conduct practical exercises regarding the application of the SSE technique in philosophy, mathematics or artificial intelligence, including, normative reasoning and machine ethics.

Contents:
Introduction to and discussion of tools and practical issues closely related to the topics discussed in the lecture as well as solutions of problems that come up during working on the practical assignment.

Literature:
will be announced in lecture course

Examination
Written examination, AISE-UL: Universal Logic & Universal Reasoning (Universelle Logik & Universelles Schließen)
Description:
Oral examination concerning the topics discussed in the lecture, exercises and assignment. Students may choose English or German as the language for the written assignment and oral examination. Examinations will take at the end of the summer term or at the beginning of the winter term (students may choose one of them). Students are assumed to work on an advanced modelling assignment ('schriftliche Hausarbeit') during the semester that is introduced at the beginning of the semester and uses the most important technologies (such as the See technique) discussed during the semester.

Note: Without working on the modelling assignment over the term students may run into problems during their oral examination (Kolloquium) as we discuss questions concerning topics from the lectures as well as from the assignment; questions about the assignment are based on the assignment solution modelled by the students.

Module Units

AISE-UL: Universal Logic & Universal Reasoning (Universelle Logik & Universelles Schließen) — **2,00 Weekly Contact Hours**
Mode of Delivery: Practicals
Lecturers: Prof. Dr. Christoph Benzmüller
Language: English
Frequency: every winter semester

Learning outcome:
The participants of this course will, in combination with a hands-on introduction to Isabelle/HOL, learn about HOL, about semantical embeddings (SSE technique) of non-classical logics in HOL, and about proof automation of these logics in Isabelle/HOL. They will conduct practical exercises regarding the application of

the SSE technique in philosophy, mathematics or artificial intelligence, including, normative reasoning and machine ethics. **Contents:** Knowledge representation and reasoning applications in computer science, AI, philosophy and math typically employ very different logic formalisms. Instead of a "single logic that serves it all" (as envisioned already by Leibniz) an entire "logic zoo" has been developed, in particular, during the last century. Logics in this zoo, e.g., include modal logics, conditional logics, deontic logics, multi-valued logics, temporal logics, dynamic logics, hybrid logics, etc. In this lecture course we will introduce, discuss and apply a meta logical approach to universal logical reasoning that addresses this logical pluralism. The core message is this: While it might not be possible to come up with a universal object logic as envisioned by Leibniz, it might in fact be possible to have a universal meta logic in which we can semantically model, analyse and apply various species from the logic zoo. Classical higher order logic (HOL) appears particularly suited to serve as such a universal meta logic, and existing reasoning tools for HOL can fruitfully be reused and applied in this context. **Literature:** will be announced in lecture course	

Module AlgoK-AK-B algorithms and complexity *Algorithmen und Komplexität*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Isolde Adler	
Contents: Algorithms and problem solving lie at the heart of computer science. Given an algorithmic problem, such as the Traveling Salesperson Problem, how can we design an efficient algorithm? Once we found an algorithm that solves the problem correctly, can we be sure that the resources, such as running time, storage space (and related: energy), required by this algorithm are really necessary for solving the problem? Perhaps we can do better?	
Learning outcomes: Demonstrate an understanding of what constitutes an efficient and an inefficient solution to a computational problem, - Analyse the efficiency of algorithms, - Evaluate and justify appropriate ways to provide efficient solutions for computational problems, - Identify and apply different design principles in the design of algorithms, - Describe efficient algorithms for a range of computational problems, along with their computational complexity, - Describe the use of complexity classes and the relations between them, - Articulate the key concepts and critically evaluate approaches in a clear and rigorous manner, - Appreciate and understand in-depth the role of proofs in the area of algorithm design, - Recognise how the methods learned can be extended and used to solve other problems.	
prerequisites for the module: Keine	
Recommended prior knowledge: Algorithms and data structures, basic knowledge of computability theory, proof techniques. Good English language skills.	**Admission requirements:** none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
AlgoK-AK-B (Algorithmen und Komplexität) **Mode of Delivery:** Lectures and Practicals **Language:** English/German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Learning outcome: Demonstrate an understanding of what constitutes an efficient and an inefficient solution to a computational problem, - Analyse the efficiency of algorithms, - Evaluate and justify appropriate ways to provide efficient solutions for computational problems, - Identify and apply different design principles in the design of algorithms, - Describe efficient algorithms for a range of computational problems, along with their computational complexity, - Describe the use of complexity classes and the relations between them, - Articulate the key concepts and critically evaluate approaches in a clear and rigorous manner, - Appreciate and understand in-depth the role of proofs in the area of algorithm design, - Recognise how the methods learned can be extended and used to solve other problems.	
Contents: Algorithms and problem solving lie at the heart of computer science. Given an algorithmic problem, such as the Traveling Salesperson Problem, how can we design an efficient algorithm? Once we found an algorithm that solves the problem correctly, can we be sure that the resources, such as running time, storage space (and related: energy), required by this algorithm are really necessary for solving the problem? Perhaps we can do better?	

Examination Oral examination **Description:** Die Prüfungsdauer wird in der ersten LV bekannt gegeben	

Module AlgoK-ALDAI-B Algorithms and logic in data science and AI *Algorithms and logic in data science and AI*	6 ECTS / 180 h
(since WS25/26) Person responsible for module: Prof. Dr. Isolde Adler further responsible : Stefanie Dettmer	
Contents: The past few decades saw an unprecedented increase in the size and complexity of data. We are surrounded by data in everyday life wherever we look. Understanding and analysing this data poses a huge challenge. Many current methods rely in neural networks and heuristics, at the price of sacrificing any guarantees on the computed output. However, guarantees are indispensable in many application areas, such In this module we discuss modern algorithmic approaches that come with guarantees both on the quality of the computed output and on the resource consumption. We also show lower bounds, i.e. infeasibility results. Furthermore, we uncover and exploit surprising connections between different areas of computer science.as aviation, cyber-security, finance, medicine and scientific research.	
Learning outcomes: In this module we discuss modern algorithmic approaches that come with guarantees both on the quality of the computed output and on the resource consumption. We also show lower bounds, i.e. infeasibility results. Furthermore, we uncover and exploit surprising connections between different areas of computer science.	
prerequisites for the module: Successful completion of Inf-DM-B, Inf-LBR-B and AI-AuD-B. Solid mathematical skills, including proof techniques and first-order logic, and a general interest in theoretical methods	
Recommended prior knowledge: Preferable but not compulsory: successful completion of AlgoK-AK-B.	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units	
Algorithms and logic in data science and AI **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Learning outcome: The topics include machine learning with guarantees, highly efficient property testing algorithms for huge graphs, networks and databases, exploiting tame structure of inputs via treewidth, designing fixed-parameter algorithms for notoriously hard problems, tackling	

various computational problems simultaneously through logic, highlighting applications in computational biology and exploiting connections between database query evaluation and constraint satisfaction in AI.	
Contents: The past few decades saw an unprecedented increase in the size and complexity of data. We are surrounded by data in everyday life wherever we look. Understanding and analysing this data poses a huge challenge. Many current methods rely in neural networks and heuristics, at the price of sacrificing any guarantees on the computed output. However, guarantees are indispensable in many application areas, such as In this module we discuss modern algorithmic approaches that come with guarantees both on the quality of the computed output and on the resource consumption. We also show lower bounds, i.e. infeasibility results. Furthermore, we uncover and exploit surprising connections between different areas of computer science.aviation, cyber-security, finance, medicine and scientific research.	

Examination No type selected	

Module AlgoK-TAG Baumzerlegungen, Algorithmen und Spiele *Tree decompositions, algorithms and games*	6 ECTS / 180 h

(since WS23/24)
Person responsible for module: Prof. Dr. Isolde Adler

Contents:
Many classical algorithmic problems on graphs are hard, e.g. NP-hard, in general. However, they lie at the core of many applications, so they need to be solved in practice. These problems include the famous Graph Colouring Problem, and problems such as Hamiltonian Cycle, Independent Set, Dominating Set, Vertex Cover and many more.
Ideally, we would like to solve these problems exactly and efficiently. Indeed, many problems become solvable in linear time if we only allow trees as inputs. This observation is the starting point of the module. We then identify more general classes of input graphs that allow solving many problems efficiently.
For this we make use of so-called tree decompositions of graphs. Tree decompositions allow us to obtain "tree like" graphs that are more general than trees but maintain the favourable algorithmic properties of trees.
In the first part of the module we study tree decompositions via a cops-and-robber game played on graphs, where the winning strategies for the cops yield the desired decompositions. We then develop algorithms for tree decompositions and algorithms to solve problems efficiently making use of tree decompositions.
In the second part of the module we introduce monadic second order logic (MSO) on graphs and we prove a famous theorem by Bruno Courcelle that shows how to solve **all** problems expressible in MSO efficiently on "tree-like" graphs. This includes all aforementioned algorithmic problems.
We make links to state-of-the-art research in the area and to practical applications, e.g. in compiler construction.

Learning outcomes:
On completion of this module, students should
- be familiar with classical NP-complete problems on graphs and how to solve them efficiently on trees using dynamic programming
- be able to demonstrate an in-depth understanding of tree decompositions, algorithms for computing tree decompositions, and algorithms on tree decompositions
- be able to demonstrate an in-depth understanding of the cops-and-robber game, its game theoretic properties and its connection to tree decompositions
- be able to design algorithms for the relevant problems, including analysis of runtime and correctness proofs
- be able to explain the main results covered by the module, in particular Courcelle's Theorem, demonstrating an understanding by discussing examples and knowing the main proof ideas
- be aware of the practical applications and limitations of the results
- appreciate and understand in-depth the role of proofs in the area of algorithm design

- recognise how the methods learned can be extended and used to solve other problems.

Remark:
The workload for this module is approxmately structured as follows:

- Participation in lectures and tutorials: 45 hrs
- Preparing and revising the lectures and tutorials: 60 hours
- Solving the worksheets: 45 hrs
- Exam preparation: 30 hrs

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
Prerequisites: Algorithms and data structures, basic knowledge of predicate logic, proof techniques, interest in combinatorial games on graphs. Good English language skills.	none

Frequency: every winter semester	**Recommended semester:** from 3.	**Minimal Duration of the Module:** 1 Semester

Module Units

Tree Decompositions, Algorithms and Games — **4,00 Weekly Contact Hours**
Mode of Delivery: Lectures and Practicals
Language: English/German
Frequency: alle 4 Semester

Contents:
The lectures introduce the topics, providing an in-depth explanation including motivation, intuition, examples and proofs, as well as tools, techniques and applications.

The tutorials consist of hands-on problem solving, including exam-style problems.

Literature:

- Reinhard Diestel: Graph Theory, Springer 2017
- Jörg Flum, Martin Grohe: Parameterized Complexity Theory, Springer 2010
- Anthony Bonato, Richard J. Nowakowski: The Game of Cops and Robbers on Graphs, American Mathematical Society, 2011
- Bruno Courcelle, Joost Engelfriet: Graph Structure and Monadic Second-Order Logic: A Language-Theoretic Approach (Encyclopedia of Mathematics and its Applications Book 138), Cambridge University Press, 2012

Examination
No type selected / Duration of Examination: 90 minutes
Description:
Oral exam (30 minutes) or written exam (90 minutes).

Depending on the number of participants, the exam will either be an oral exam or a written exam. The mode of examination will be communicated in the first lecture.

Module CG-VRAR-M Virtual Reality / Augmented Reality *Virtual Reality / Augmented Reality*	6 ECTS / 180 h
(since SS25) Person responsible for module: Prof. Dr. Sophie Jörg	

Contents:

Virtual Reality (VR) and Augmented Reality (AR) are gaining in popularity. Virtual Reality allows users to explore interactive worlds by being immersed in a fully computer-generated environment. Augmented Reality (AR) enhances the real world by overlaying digital content onto the physical world. Applications include education, training, simulation, architecture, design, tourism, manufacturing, healthcare, navigation, entertainment, and social interactions.

This course introduces students to the funcamental principles of Virtual Reality and Augmented Reality. The core topics are

- Basic Principles and Visual Perception
- Display Technologies from Head-Mounted Displays for VR to handheld AR devices
- Tracking Technologies
- Navigation and Interaction
- Avatars and Self-Avatars
- Evaluating AR and VR Experiences and Systems

Learning outcomes:

At the end of this course, students have a comprehensive understanding of the principles associated with VR and AR technologies. They understand how different display and tracking technologies work. Students can determine the basic requirements on hardware, interaction, and interface configurations for specific applications. They are able to design, implement, and evaluate a VR and AR system for a specified application.

prerequisites for the module:

Keine

Recommended prior knowledge: Programming skills in C# (or C++ or Java).		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Virtual Reality / Augmented Reality **Mode of Delivery:** Lectures **Language:** English/German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: See module description.	
Literature: Literature will be specified at the beginning of the course.	
2. Virtual Reality / Augmented Reality **Mode of Delivery:** Practicals	**2,00 Weekly Contact Hours**

Language: English/German **Frequency:** every summer semester **Contents:** The labs will apply and expand the knowledge gained in the lectures with experience in the practical implementation of VR and AR systems. To this aim, students are required to complete assignments and projects.	

Examination Written examination **Description:** Die Prüfungsdauer wird in der ersten LV bekannt gegeben.	

Module DS-ConvAI-M Advanced Dialogue Systems and Conversational AI *Advanced Dialogue Systems and Conversational AI*	6 ECTS / 180 h

(since SS25)
Person responsible for module: Prof. Dr. Stefan Ultes

Contents:
This module deals with state-of-the-art approaches to Conversational AI - text-based or speech-based dialogue interaction through language - and its modelling and realisation through machine learning and deep learning. Building upon content of the module DS-IDS-B, it dives into the technical realization of chatbots and spoken dialogue systems ranging from a modular pipeline architecture to end-to-end neural models including Large Language Models (LLMs). The module can be successfully completed without prior knowledge on dialogue systems.

Learning outcomes:
In this course, students will learn about various technological aspects of Conversational AI with a focus on state-of-the-art neural and deep learning approaches. After successfully completing this course, students will be able to

- know the inner workings of Large Language Models and how they can be applied to build dialogue systems
- compare state-of-the-art methods of Conversationa AI with each other based on the models' apabilties and limitations
- understand basic and advanced concepts of neural language modelling like Recurrent Neural Networks and Transformer models
- able to apply extensions of language models to build dialogue systems
- able to explain how neural language models can be used for building dialogue system
- able to explain lingusitic encoding strategies and their impact on down-stream computation
- understand theoretical foundations of Conversational AI and dialogue systems technology and modelling
- understand various technological aspects of Conversational AI with a focus on state-of-the-art neural and deep learning approaches to sequential and non-sequential supervised learning
- understand dialogue modelling through reinforcement learning and deep reinforcement learning and how to derive a suitable objective function
- understand how to make use of advanced deep learning architectures like recurrent neural networks and transformers for their application on various problems of dialogue systems and the dialogue system itself

The lecture is accompanied by practicals and assignments that will help participants to develop practical, hands-on experience. In those practicals, students will implement and evaluate different approaches for dialogue systems and its modules using machine learning algorithms using Python and its respective commonly used libraries. Thus, students gain the ability to:

- apply llms to conv ai-related tasks and to build dialogue systems
- apply different prompting strategies including RAG and how to evaulate them
- examin implementations of dialogue system modules and how to evaluate them

Remark:
The lecture is conducted in English. The workload of this module is expected to be roughly as follows:

- Lecture: 21h
- Preparation of lectures and analysis of further sources: 30h
- Practicals accompanying lecture: 21h
- Work on the actual assignments: 75h
- Preparation for exam: 30h

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
Good working knowledge of programming (e.g., in Python); Recommended (not mandatory) completion of modules: Einführung in Maschinelles Lernen/Introduction to Machine Learning (KogSys-ML-B), Einführung in die Dialogsysteme/Introduction to Dialogue Systems [DS-IDS-B], Deep Learning [xAI-DL-M]	none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units

1. Advanced Dialogue Systems and Conversational AI — **2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Lecturers: Prof. Dr. Stefan Ultes
Language: English/German
Frequency: every summer semester

Learning outcome:
see module description

Contents:
The lecture will be held in English. The following is a selection of topics that will be addressed in the course:

- Large Language Models and their application in Conversational AI
- End-to-end Neural Dialogue Generators
- Machine-larning based methods to various spoken dialogue system modules
- Statistical Spoken Dialogue Systems
- Evaluation techniques

Literature:
AI and NLP generally:

- Artificial Intelligence: A Modern Approach (Stuart Russell and Peter Norvig)
- Deep Learning (Ian Goodfellow and Yoshua Bengio)
- Speech and Language Processing (Dan Jurafsky and James Martin)

Covnersational AI and Dialogsysteme:

- Conversational AI: Dialogue Systems, Conversational Agents, and Chatbots (Michael McTear)
- Transforming Conversational AI: Exploring the Power of Large Language Models in Interactive Conversational Agents (Michael McTear)
- Natural Language Generation (Ehud Reiter)

• Natural Language Processing with Transformers: Building Language Applications With Hugging Face (Lewis Tunstall) **Reinforcement Learning:** • Reinforcement Learning: An Introduction (Richard Sutton and Andrew Barto) • Grokking Deep Reinforcement Learning (Miguel Morales)	
2. Advanced Dialogue Systems and Conversational AI (Practicals) **Mode of Delivery:** Practicals **Lecturers:** N.N. **Language:** English/German **Frequency:** every summer semester **Learning outcome:** see module description **Contents:** Further exploration of concepts discussed in the lecture, often accompanied by assigments and programming exercises implemented in Python and the corresponding machine/deep learning libraries.	**2,00 Weekly Contact Hours**

Examination Oral examination / Duration of Examination: 30 minutes **Description:** Depending on the number of participants, the exam can also be a written exam (Klausur/E-Prüfung). The final decision will be announced within the first three weeks of the lecture period. The content that is relevant for the exam consists of the content presented both in the lectures and in the practicals (including the assignments).	

Module DT-CPP-B Introduction into Systems Programming in C++ *Einführung in die Systemprogrammierung in C++*		6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Maximilian Schüle		
Contents: Vertiefung der Kenntnisse über moderne C++-Programmiertechniken und das C++-Ökosystem, Erlernen des Schreibens von gutem C++, Erlernen der Implementierung großer Systeme mit C++, Erlernen des Schreibens von Hochleistungscode mit C++. Wir erwarten nicht, dass Sie bereits Erfahrung in der Programmierung mit C oder C++ haben, aber Sie sollten mit einer allgemeinen Programmiersprache Ihrer Wahl vertraut sein. Außerdem sollten Sie mit gängigen Algorithmen und Datenstrukturen sowie mit Computerarchitektur und Betriebssystemen vertraut sein.		
Learning outcomes: Systemprogrammierung in C++		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:** from 3.	**Minimal Duration of the Module:** 1 Semester

Module Units	
Einführung in die Systemprogrammierung in C++ **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Maximilian Schüle **Language:** English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**
Contents: Vertiefung der Kenntnisse über moderne C++-Programmiertechniken und das C++-Ökosystem, Erlernen des Schreibens von gutem C++, Erlernen der Implementierung großer Systeme mit C++, Erlernen des Schreibens von Hochleistungscode mit C++. Wir erwarten nicht, dass Sie bereits Erfahrung in der Programmierung mit C oder C++ haben, aber Sie sollten mit einer allgemeinen Programmiersprache Ihrer Wahl vertraut sein. Außerdem sollten Sie mit gängigen Algorithmen und Datenstrukturen sowie mit Computerarchitektur und Betriebssystemen vertraut sein.	
Examination Portfolio / Duration of Coursework: 4 months	

Module DT-CPP-M Advanced Systems Programming in C++ (Master) *Fortgeschrittene Systemprogrammierung in C++ (Master)*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Maximilian Schüle	
Contents: In diesem Modul wird die fortgeschrittene Systemprogrammierung in C++ gelehrt. Dabei lernen die Teilnehmer nicht nur ihr Wissen in kleinen Programmierhausaufgaben anzuwenden sondern auch das gelernte Wissen in einer übergreifenden Projektarbeit zu kombinieren.	
Learning outcomes: Anwendung komplexer C++-Systemprogrammierung in eigenständiger Projektarbeit	
prerequisites for the module: none	

Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:** from 3.	**Minimal Duration of the Module:** 1 Semester

Module Units	
Fortgeschrittene Systemprogrammierung in C++ (Master) **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Maximilian Schüle **Language:** English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**
Learning outcome: Anwendung komplexer C++-Systemprogrammierung in eigenständiger Projektarbeit	
Contents: In diesem Modul wird die fortgeschrittene Systemprogrammierung in C ++ gelehrt. Dabei lernen die Teilnehmer nicht nur ihr Wissen in kleinen Programmierhausaufgaben anzuwenden sondern auch das gelernte Wissen in einer übergreifenden Projektarbeit zu kombinieren.	
Literature: Primary • C++ Reference Documentation • Lippman, 2013. C++ Primer (5th edition). • Stroustrup, 2013. The C++ Programming Language (4th edition). • Meyers, 2015. Effective Modern C++. 42 Specific Ways to Improve Your Use of C++11 and C++14. Supplementary • Aho, Lam, Sethi & Ullman, 2007. Compilers. Principles, Techniques & Tools (2nd edition).	

• Tanenbaum, 2006. Structured Computer Organization (5th edition).	
Examination Portfolio / Duration of Coursework: 4 months	

Module DT-DBCPU-M Database Systems for modern CPU *Datenbanksysteme für moderne CPU*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Maximilian Schüle	
Contents: This lecture covers the implementation of database systems, including how to leverage modern hardware architectures, for example vector intrinsics (AVX-512) and CUDA programming for GPU. Diese Vorlesung behandelt die Implementierung von Datenbanksystemen, einschließlich der Nutzung moderner Hardware-Architekturen, z.B. Vektorinstruktionen (AVX-512) und CUDA-Programmierung für die GPU.	
Learning outcomes: Understand the concepts of database systems and be able to implement database systems, also for modern hardware Konzepte von Datenbanksystemen verstehen und Datenbanksysteme implementieren können inkl. für moderne Hardware	
prerequisites for the module: none	

Recommended prior knowledge: MOBI-DBS-B		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Datenbanksysteme für moderne CPU **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Maximilian Schüle **Language:** English **Frequency:** every summer semester	**4,00 Weekly Contact Hours**
Learning outcome: Understand the concepts of database systems and be able to implement database systems, also for modern hardware Konzepte von Datenbanksystemen verstehen und Datenbanksysteme implementieren können inkl. für moderne Hardware	
Contents: This lecture covers the implementation of database systems, including how to leverage modern hardware architectures, for example vector intrinsics (AVX-512) and CUDA programming for GPU. Diese Vorlesung behandelt die Implementierung von Datenbanksystemen, einschließlich der Nutzung moderner Hardware-Architekturen, z.B. Vektorinstruktionen (AVX-512) und CUDA-Programmierung für die GPU.	
Literature:	

- Theo Härder, Erhard Rahm.Datenbanksysteme: Konzepte und Techniken der Implementierung.Springer, Berlin; 2nd ed.
- Hector Garcia-Molina, Jeff Ullman, Jennifer Widom. *Database Systems: The Complete Book*
- D. E. Knuth.The Art of Computer Programming Volume III
- Joseph M. Hellerstein, Michael Stonebraker, James Hamilton.Architecture of a Database System
- Franz Faerber, Alfons Kemper, Per-Åke Larson, Justin J. Levandoski, Thomas Neumann, Andrew Pavlo.Main Memory Database Systems

Examination

Written examination / Duration of Examination: 90 minutes

Module EESYS-ADAML-M Applied Data Analytics and Machine Learning in R *Applied Data Analytics and Machine Learning in R*	6 ECTS / 180 h

(since SS21)
Person responsible for module: Prof. Dr. Thorsten Staake

Contents:

This course provides the theoretical foundation and conveys hands-on skills in the fields of data analytics and machine learning using the statistics software GNU R. It uses real-word datasets from the realm of energy efficiency and consumer behavior and conveys the subject matter through real-world examples and practical challenges.

Following a refresher in descriptive statistic, the course covers

- an introduction to the statistics software GNU R,
- the design of field experiments and the use of Information Systems to collect behavioral data,
- techniques to formulate, solve, and interpret linear and logistic regression analyses,
- techniques to formulate, solve, and interpret clustering analyses,
- setting up, training, and evaluating machine learning algorithms, including KNN, regression, and support vector machines, and
- ethical issues and data privacy regulations.

Learning outcomes:

After a successful participation in this course, participants can

- translate new business and research questions that can be answered using empirical methods into suitable experimental designs,
- plan and conduct corresponding experiments,
- choose suitable methods from the set of methods presented in class to analyze the data,
- explain their design choices, the choice of methods, and the steps of the analyses,
- apply the methods correctly and efficiently using the statics software R,
- adjust the methods if needed to solve new and specific problems based on an understanding of the necessary theories,
- interpret the outcome of such analyses and identify the strengths and limitations of the approaches, and
- reflect upon data protection, privacy and ethical issues related to powerful techniques for data acquisition and analytics.

Remark:

The lecture will be held as a self-paced, video-based online lecture.

The tutorials take place once per week as in-classroom events.

The online lecture includes instructional videos (scripted, i.e., with subtitles), reading material, exemplary data sets, and a multitude of online and offline tasks. It also includes an online discussion forum.

The online lecture is supported by three classroom lectures (in addition to the classroom tutorials):

1. Classroom lecture: The introductory event includes a course overview and motivation. Moreover, credentials to access the online resources will be announced. Date: First week of the semester.

2. Classroom lecture: This intermediate session includes a review of the concepts covered so far. It should help participants to self-assess their learning progress. Date: Announced in the first week of the semester.
3. Classroom lecture: Exam preparation and Q&A. Date: Last week of the semester.

An introduction to the statistics software GNU R will be given as in-classroom event during the tutorials at the beginning of the semester.

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
This course requires a basic understanding of statistics (e.g., from a bachelor-level course). A statistics repetition and is part of the online material of the course and the of the first tutorials and should be complemented in self-study if necessary. Basic familiarity with a programming language.	none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Lectures Data Analytics in Energy Informatics — **2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Lecturers: Prof. Dr. Thorsten Staake
Language: German/English
Frequency: every winter semester

Contents:
The video-based online lecture is divided into two parts. Part 1 conveys the statistical basics required for the module, including, for example, properties of random distributions and descriptive and injunctive statistics. This part serves as refresher of bachelor-level statistics and thereby enables students with no statistics-knowledge beyond a basic introductory course to participate. Part 2 covers the methods outlined in “Module EESYS-DAE-M” subsection “Contents”. It includes both, the theory behind the concepts and their application using R. Both, Part 1 and Part 2 use datasets and examples from industry and research and provides many hands-on examples. In order to deepen the understanding and to ease the transfer of the methods to new problems and settings, mini-tasks and small exercises are part of the online lecture.

Literature:
Reading material will be announced in class.

2. Practicals Data Analytics in Energy Informatics — **2,00 Weekly Contact Hours**

Mode of Delivery: Practicals
Language: German/English
Frequency: every winter semester

Contents:
In the classroom tutorial, participants apply the methods, tools, and theories conveyed in the lecture to exemplary problems and to new challenges. This includes solving smaller tasks (e.g., acing case studies, working on concrete

data problems) on paper and using the statistics software GNU R. Tasks are addressed individually or in small teams. The tutorials can also cover new content, especially when its immediate application supports the learning process. Selected tutorials contain a self-assessment of the learning progress. An introduction to GNU R is given in the first sessions.	

Examination Written examination / Duration of Examination: 90 minutes **Description:** The examination covers subject matter taught in the lectures and tutorials. The examination can also cover transfers of the subject matter to new problems and settings. Students can achieve up to 90 points. Through the voluntary completion of coursework (“bonus exercises”) during the semester, participants can collect up to 12 additional points that are counted towards the exam, given that the exam is passed also without points from bonus exercises. Bonus exercises can take the form of written assignments, presentations, or smaller software projects. Points from bonus exercises are only valid in the semester they have been earned in and in the immediately following semester. In the first week of the course, the publishing dates of bonus exercise tasks, the submission deadlines, and the points per bonus exercise will be announced. It is possible to pass the exam with a grade of 1.0 also without points from bonus exercises. Exam questions are stated in English, answers can be given in German or English.	

Module EESYS-ES-M Energy Efficient Systems *Energieeffiziente Systeme*		6 ECTS / 180 h
(since WS19/20) Person responsible for module: Prof. Dr. Thorsten Staake		
Contents: The course covers the design and application of Information Systems that help increase energy efficiency and reduce greenhouse gas emissions. It is directed to computer science and Information Systems students that want to apply their skills to challenges in the fields of energy, mobility, production, and sustainable consumption/consumer behavior. The course introduces methods and theories from behavioral economics, operations management, and simulation analysis that help to understand, analyze, and shape both, industry processes and consumer behavior in the field of sustainability. Also covered are cost/benefit considerations on a micro- and macro-level (including, for example, rebound effects) and a discussion on the economic and societal implications of the subject matter. The course includes an introduction to physics and energy engineering to allow students with very limited knowledge in these fields to participate successfully.		
Learning outcomes: Successful participants of this course shall acquire the skills to • explain the physical and technical principals covered in this course and apply them to new problems, • explain the components, influencing factors, requirements and challenges related to electric mobility and describe the contribution that Information Systems can make to solve the challenges; moreover, successful participants shall be able to set up data-based simulations to derive important characteristic variables related to electric vehicles, such as electric reachability, peak loads to electric grids, etc., • outline, assess, and conceptually model the potential of Information Systems and the effects to heating and room climate applications, • explain in detail the characteristics of and implications from environmental business Information Systems, • explain the discussed behavioral theories (e.g., the prospect theory), make use of them when building Information Systems that support decision making and behavioral change, and be able to evaluate the effectiveness of such systems, and • evaluate the effects of the tools and methods introduced, including their micro- and macro-economic effects, and critically assess the techniques used to perform such evaluations. Moreover, successful participants shall be able to apply the acquired skills to new challenges and adjust and extend them as needed. Finally, the participants shall realize the scope for design and the potential that results from their IT studies to favorably shape a sustainable and socially desirable development of our society.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Energy Efficient Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Thorsten Staake **Language:** German/English **Frequency:** every summer semester **Contents:** The lecture covers the topics mentioned in “Module EESYS-ES-M”, subsection “Contents”. It uses traditional lecture elements, discussions, exercises, and group work to support participants in reaching the learning objectives. Special emphasis is placed on working on cases and on discussions of studies and scientific publications. Methods, tools, and theories are introduced with references to practical challenges and are applied to exemplary problems. For selected topics, the lecture relies on flipped classroom elements for which participants need to acquire knowledge in advance (e.g., through reading tasks), which is then critically reflected and extended in the classroom sessions. **Literature:** Weiterführende Unterlagen werden in der Veranstaltung bekanntgegeben.	**2,00 Weekly Contact Hours**
2. Practicals Energy Efficient Systems **Mode of Delivery:** Practicals **Language:** German/English **Frequency:** every summer semester **Contents:** The first tutorials convey basics in physics and electrical engineering in order to also allow students who did not take related modules to participate in this course. Subsequently, participants apply the methods, tools, and theories conveyed in the lecture to exemplary problems and to new challenges. Tutorials include small tasks, case studies, and reviews of scientific publications that are addressed individually or in small teams. The tutorials can also cover new content, especially when its immediate application supports the learning process. Selected tutorials contain a self-assessment of the learning progress. **Literature:** Reading material will be announced in class.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The examination covers subject matter taught in the lectures and tutorials. The examination can also cover transfers of the subject matter to new problems and settings. Students can achieve up to 90 points. Through the voluntary completion of coursework (“bonus exercises”) during the semester, participants can collect up to 12 additional points that are counted	

towards the exam, given that the exam is passed also without points from bonus exercises. Bonus exercises can take the form of written assignments, presentations, or smaller software projects. Points from bonus exercises are only valid in the semester they have been earned in and in the immediately following semester. In the first week of the course, the publishing dates of bonus exercise tasks, the submission deadlines, and the points per bonus exercise will be announced. It is possible to pass the exam with a grade of 1.0 also without points from bonus exercises. Exam questions are stated in English, answers can be given in German or English.	

Module ESE-ESEng-M Evidence-based Software Engineering *Evidence-based Software Engineering*	6 ECTS / 180 h
(since WS25/26) Person responsible for module: Prof. Dr. Matthias Galster	
Contents: In software engineering there are many fashions, hypes and folklore, but we often do not know what *really* works and when. The notion of “evidence-based” software engineering is inspired by evidence-based medicine and aims at improving the professional decision making of software engineers. The course explores how to find, generate, interpret, report and use different forms of evidence for software engineering practice and applied research.	
Learning outcomes: After completing this course, students will be able to: • Understand the importance of evidence in software development and the meaning of evidence for practitioners • Apply evidence-based methods and techniques to create and synthesizing evidence • Understand how to report evidence to different stakeholders • Assess ethical considerations when dealing with evidence in software engineering	
Remark: The main language of instruction is English.	
prerequisites for the module: none	
Recommended prior knowledge: The course assumes that students have knowledge of computer science and software engineering (e.g., analysis, design, implementation, programming, testing).	**Admission requirements:** none

Frequency:	**Recommended semester:**	**Minimal Duration of the Module:**
		1 Semester

Module Units	
1. Lab **Language:** English/German **Learning outcome:** See module description. **Contents:** Labs will complement lectures. Also, students may deliver short presentations. **Literature:** Literature will be announced in the lectures.	**2,00 Weekly Contact Hours**
2. Lecture **Language:** English/German **Frequency:** every winter semester **Learning outcome:**	**2,00 Weekly Contact Hours**

See module description. **Contents:** see module description **Literature:** Literature will be announced in the lectures.	

Examination No type selected **Description:** The exam might be based on a mini-project including a report and presentations.	

Module ESE-SRE-B Software Requirements Engineering *Software Requirements Engineering*	6 ECTS / 180 h
(since SS25) Person responsible for module: Prof. Dr. Matthias Galster	

Contents:
Many software engineering problems are rooted in not understanding and properly managing the needs of customers and other stakeholders during the development and maintenance of software. The course discusses concepts for systematically identifying, defining, and managing software requirements.
The course will also explore the synergistic relationship between software requirements and software architecture design in iterative and incremental software development.

Learning outcomes:
After completing this course, students will be able to:

- Recognize the importance of systematically understanding and managing software requirements
- Apply systematic requirements engineering practices for eliciting, documenting, and analyzing software requirements
- Understand the relationship between software requirements and architecture design decisions
- Identify and interpret the current state-of-the-art and practices of requirements engineering, including background literature

Remark:
The main language of instruction is English.

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
The course assumes that students have basic knowledge of computer science and software engineering (e.g., analysis, design, implementation and programming, testing). Recommended preparation: (1) SWT-FSE-B Foundations of Software Engineering; (2) INF-EINF-B Einführung in die Informatik	none

Frequency: every summer semester	**Recommended semester:** from 3.	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Lecture **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Matthias Galster **Language:** English/German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**

Learning outcome:
see module description

Contents:
see module description

Literature:

Literature will be announced in the lectures.	
2. Lab **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Matthias Galster **Language:** English/German **Frequency:** every summer semester **Learning outcome:** See module description. **Contents:** Labs will cover material presented in the lectures. Furthermore, students may deliver short presentations. **Literature:** Literature will be announced in the lectures.	**2,00 Weekly Contact Hours**

Examination No type selected **Description:** The mode (oral or written) and duration of the examination will be announced in the first lecture. The exam covers all course contents (lectures, labs). The exam is set in English, but answers may be provided in either English or German. To pass the exam, students must achieve at least 50% of marks awarded for the exam.	

Module GAMES-DGS-M Designing Gamified Systems *Designing Gamified Systems*	6 ECTS / 180 h

(since SS25)
Person responsible for module: Prof. Dr. Benedikt Morschheuser

Contents:

Driven by the rising popularity of digital games, technology, business, and society are increasingly influenced by trends in the gaming industry. One of the probably most important phenomena of this multi-faceted development is “gamification”, which refers to the use of design principles and features from games when designing information systems, processes, or services to afford similar positive experiences, skills, and practices as found in games and facilitate changes in behaviors.

In recent years, gamification has become an umbrella term that encompasses and includes, to varying degrees, other related technological developments such as serious games, game-based learning, exergames, games with a purpose/human computation games and persuasive technology. Further, gamification is applied across industries, such as marketing, commerce, software development, education, logistics, and healthcare.

This course:

- teaches key concepts, design patterns, and approaches of gamified and hedonic (i.e., games and video games) information systems.
- offers deep insights into the theoretical foundations of game design, motivational psychology, and information system design.
- introduces methods and frameworks for designing gamified systems and managing gamification projects.
- discusses latest research findings and the potential impact of gamification on society, economy, and everyday life.

The course is complemented by a practical design project, where students in a team select and apply design methods & techniques in order to create a prototype of a gamified / hedonic information system. Within this project, the students can apply the knowledge and skills acquired in this lecture and their studies in a challenging context.

Learning outcomes:

Students gain knowledge in the conceptual, technological and theoretical foundations of gamified and hedonic information systems. They learn to describe and discuss their underlying design principles as well as their psychological and behavioral outcomes. They can analyze and compare existing gamified and hedonic information systems and learn to critically reflect relevant ethical aspects of using gamification in practice. Students learn state-of-the-art methods, techniques, and tools for successfully implementing gamification projects and are able to select and apply them. Students train their creativity and prototyping skills. Further, they can improve their collaboration and presentation skills in this course.

Remark:

The workload for this module is roughly broken down as follows:

- Participation in lectures (~40h)
- Participation at project sessions (~10h)
- Self-study and work on group project (~110h)
- Preparation for exam (~20h)

The number of participants for this course is limited. If, due to capacity restrictions, a selection of students in courses with limited admission capacity becomes necessary, a decision on admission will be made after the registration period has expired. Please also note that registration for the course does not automatically lead to admission nor registration for the module examination. Please see website for details on the application process.

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
Profound English skills are required. Further, creativity, experience in HCI, user experience, prototyping, and software engineering are helpful. Participating students should be motivated to work on a challenging topic in interdisciplinary groups.	Active participation in the group project

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Designing Gamified Systems — **4,00 Weekly Contact Hours**

Mode of Delivery:
Lecturers: Prof. Dr. Benedikt Morschheuser
Language: Deutsch / English on demand
Frequency: every summer semester

Learning outcome:
Students gain knowledge in the conceptual, technological and theoretical foundations of gamified and hedonic information systems. They learn to describe and discuss their underlying design principles as well as their psychological and behavioral outcomes. They can analyze and compare existing gamified and hedonic information systems and learn to critically reflect relevant ethical aspects of using gamification in practice. Students learn state-of-the-art methods, techniques, and tools for successfully implementing gamification projects and are able to select and apply them. Students train their creativity and prototyping skills. Further, they can improve their collaboration and presentation skills in this course.

Contents:
This course:

- teaches key concepts, design patterns, and approaches of gamified and hedonic (i.e., games and video games) information systems.
- offers deep insights into the theoretical foundations of game design, motivational psychology, and information system design.
- introduces methods and frameworks for designing gamified systems and managing gamification projects.
- discusses latest research findings and the potential impact of gamification on society, economy, and everyday life.

Literature:
Koivisto, J & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. International Journal of Information Management, 45. pp. 191-210.

Morschheuser, B., Hassan, L., Werder, K., Hamari, J. (2018). How to design gamification? A method for engineering gamified software. Information & Software Technology, 95. pp. 219-237. Radoff, J. (2011). Game On: Energize Your Business with Social Media Games. Wiley, USA. Salen, K. (2004). Rules of play: game design fundamentals. MIT Press, Cambridge, USA. Further literature will be made available in the lecture.	

Examination Coursework Assignment and Colloquium	

Module GAMES-META-M Understanding and Designing the Metaverse (Research Project) *Understanding and Designing the Metaverse (Research Project)*	6 ECTS / 180 h
(since WS25/26) Person responsible for module: Prof. Dr. Benedikt Morschheuser	
Contents: Since the science-fiction author Neal Stephenson coined the term “metaverse” in his novel Snow Crash, a portmanteau of “meta” (Greek for beyond) and “universe”, people have been dreaming of realizing his vision of a virtual reality-based three-dimensional (3D) successor to the Internet, in which people interact with each other, virtual agents and objects in the form of avatars. This virtual universe is envisioned to exist in parallel to reality, has its own economy, culture, organizations, rules, and laws, and, similar to the Internet, is considered to be an open, distributed, and collectively created space where anyone can become a content creator and can shape this collectively created virtual world. Driven by recent cultural and societal developments # such as the increasing popularity of digital games and the acceptance of remote collaboration # as well as technological advances # such as AR and VR, 5G, blockchain technologies, cloud computing, streaming technologies, or artificial intelligence # various big technology companies have started developing platforms from which a potential metaverse could emerge soon. Metaverse-like platforms such as Roblox, Fortnite Creative, The Sandbox, VRChat, Meta Horizon Worlds, and Minecraft are already attracting millions of users to design and jointly experience virtual worlds.	
Learning outcomes: In this project seminar, students explore how the metaverse may shape the future of research, education, business, healthcare, and society as well as what current and future challenges the topic entails. Students study the ongoing scientific discourse on the topic and strive to understand what socio-technological trends may support the further development of the metaverse. To this end, the students create immersive 3D content on popular and emerging metaverse-like platforms and investigate relevant research questions related to the topic in empirical studies. The project is positioned at the intersection of Information Systems and Human-Computer Interaction and strives to create knowledge by implementing and evaluating prototypes, interactive experiments, and case studies. This project seminar applies a research-based learning approach, in which students learn how to read and understand scientific papers, develop, and evaluate hypotheses by using scientific methods, and think critically and creatively. Students learn how to solve scientific problems, challenges, and dilemmas. Further, the course trains skills for communicating in the field of science through writing and discussion and thus prepares writing a bachelor or master thesis.	
Remark: Please check our website: https://www.uni-bamberg.de/games/lehre/understanding-and-designing-the-metaverse-project/	
prerequisites for the module: none	
Recommended prior knowledge: Profound English skills are required. Further, creativity, experience in software design, user experience, prototyping, and software engineering (e.g. Unity3D, Roblox, Godot) are very helpful.	**Admission requirements:** Active participation in the group project

All participating students should be motivated to work in an international and interdisciplinary group on a challenging topic. We recommend participating in our bachelor courseImmersive Information Systemsor the master courseDesigning Gamified Systems, as both provide valuable foundational knowledge. Most of our projects require knowledge of software development. Willingnes to code is a prerequisite to participate in this course.		
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Understanding and Designing the Metaverse (Research Project) **Mode of Delivery:** **Lecturers:** Prof. Dr. Benedikt Morschheuser **Language:** Deutsch / English on demand **Frequency:** every winter semester	**0,00 Weekly Contact Hours**
Learning outcome: In this project seminar, students explore how the metaverse may shape the future of research, education, business, healthcare, and society as well as what current and future challenges the topic entails. Students study the ongoing scientific discourse on the topic and strive to understand what socio-technological trends may support the further development of the metaverse. To this end, the students create immersive 3D content on popular and emerging metaverse-like platforms and investigate relevant research questions related to the topic in empirical studies. The project is positioned at the intersection of Information Systems and Human-Computer Interaction and strives to create knowledge by implementing and evaluating prototypes, interactive experiments, and case studies. This project seminar applies a research-based learning approach, in which students learn how to read and understand scientific papers, develop, and evaluate hypotheses by using scientific methods, and think critically and creatively. Students learn how to solve scientific problems, challenges, and dilemmas. Further, the course trains skills for communicating in the field of science through writing and discussion and thus prepares writing a bachelor or master thesis.	
Contents: Since the science-fiction author Neal Stephenson coined the term “metaverse” in his novel Snow Crash, a portmanteau of “meta” (Greek for beyond) and “universe”, people have been dreaming of realizing his vision of a virtual reality-based three-dimensional (3D) successor to the Internet, in which people interact with each other, virtual agents and objects in the form of avatars. This virtual universe is envisioned to exist in parallel to reality, has its own economy, culture, organizations, rules, and laws, and, similar to the Internet, is considered to be an open, distributed, and collectively created space where anyone can become a content creator and can shape this collectively created virtual world.	

Driven by recent cultural and societal developments # such as the increasing popularity of digital games and the acceptance of remote collaboration # as well as technological advances # such as AR and VR, 5G, blockchain technologies, cloud computing, streaming technologies, or artificial intelligence # various big technology companies have started developing platforms from which a potential metaverse could emerge soon. Metaverse-like platforms such as Roblox, Fortnite Creative, The Sandbox, VRChat, Meta Horizon Worlds, and Minecraft are already attracting millions of users to design and jointly experience virtual worlds.	
Examination Coursework Assignment and Colloquium	

Module GdI-CSNL-M Computational Semantics of Natural Language *Computational Semantics of Natural Language*	6 ECTS / 180 h
(since WS23/24) Person responsible for module: Prof. Ph.D. Michael Mendler further responsible : Luke Burke	
Contents: The formal study of natural language syntax and semantics has developed as a very lively sub-field of linguistics in the past 50 years, with the typed lambda calculus in particular providing a way of giving compositional analyses of meanings in natural language. Recently, monads and continuations have been employed as tools in natural language syntax and semantics. The aim of this module is to introduce the use of monads and continuations in natural language semantics and to discuss different approaches to the formal representation of quantifier scope ambiguities in natural language. The basics of natural language semantics (typed lambda calculus) will be briefly introduced, before discussing a continuation-based approach to quantification in natural language, which will be contrasted with other approaches. Monads representing focus, intensionality and non-determinism in natural language will be discussed. We will look at how analyses of the meaning of sentences can be represented in Haskell. Importantly, the course may differ slightly from other courses in that assessment will not concentrate on technical exercises; rather, we require careful reading and dissection of relevant literature on the topic, since the primary mode of assessment will be via seminar presentations and essays, and you will be assessed on your understanding of, and your independent analysis of, relevant literature discussed in lectures. Independent reading of this literature will in fact be essential. This course may also be of interest to students in philosophy and linguistics.	
Learning outcomes: At the end of this course students should be familiar with different approaches to the formal representation of quantifier scope ambiguities in natural language; be familiar with how monads and continuations have been used in natural language semantics; be familiar with the use of Haskell to formalise analyses in natural language semantics; be able to produce and manipulate terms of the typed lambda calculus to represent how meanings combine; have an understanding of how both logics and trees have been used to represent natural language syntax; be acquainted with logics such as Montague’s “Intensional Logic” and Gallin’s Ty2.	
Remark: The workload for this module consists of: • participation in lectures and tutorial sessions: 45hrs • individual preparation and reading: 105hrs • exam preparation and oral exam: 30hrs	
prerequisites for the module: none	
Recommended prior knowledge: Willingness to read relevant literature, critically discuss and analyse it and write about it. Basic logic (Gdl-Mfl-1: Mathematik fur Informatik or an equivalent level of understanding). Some knowledge of modal logic more basic than that required for (Gdl-MTL: Modal and	**Admission requirements:** English language skills at Level B2 (UniCert II) or above.

Temporal Logic). Knowledge of the typed lambda calculus (abstraction and application) and elementary Haskell (GdI-IFP: Introduction to Functional Programming) would be very useful, though not essential.		
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units	
Computational Semantics of Natural Language **Mode of Delivery:** Lectures and Practicals **Language:** English **Frequency:** every summer semester **Contents:** Through prepared class presentations, essay writing, and direct interactions with the students the lecturer introduces the topics of the course in detail. The seminars deepen the students' understanding of the theoretical concepts and constructions covered in the lectures through presentations, which involve comparing alternative analyses of linguistic phenomena. **Literature:** • van Eijck, J. And Unger, Christina, “Computational Semantics with Functional Programming”, Cambridge University Press 2010 • Barker, C. and Shan, C.-C., “Continuations and natural language”, Volume 53. Oxford studies in Theoretical Linguistics, Oxford University Press, 2014 • Carpenter, Bob, “Type-Logical Semantics”, MIT Press (1997) • Keenan, Edward, and Stabler, Edward, “Mathematical structures in Language”, CSLI publications, Stanford, 2016 • Gallin, Daniel, “Intensional and Higher-Order Modal logic. North Holland, 1975.	**4,00 Weekly Contact Hours**

Examination Portfolio / Duration of Examination: 80 minutes **Description:** The components of the portfolio will be announced at the beginning of each semester.	

Module GdI-FPRS-M Functional Programming of Reactive Systems *Functional Programming of Reactive Systems*	6 ECTS / 180 h
(since WS23/24) Person responsible for module: Prof. Ph.D. Michael Mendler	

Contents:

Based on an existing basic knowledge of functional programming (FP), the aim of this module is to develop advanced skills in the use of FP languages to structure and solve algorithmic problems in designing interactive and concurrent systems. We will study advanced programming abstractions specifically developed for the functional modelling of synchronous reactive systems. Following the methodological structure of the introductory course GDI-IFP, this advanced course, too, combines both practical programming with a focused discussion of pertinent underlying mathematical concepts. Though we use Haskell as our main language we may also look at other FP languages such as F#, ML or OCAML where appropriate.

Learning outcomes:

At the end of this course students should

- be familiar with advanced FP programming concepts and their application (e.g., class mechanism, type families, higher-rank polymorphism, monad and arrow abstractions, lenses, continuation-style programming, stream programming, concurrency abstractions)
- be able to use these advanced language concepts to solve complex algorithmic problems efficiently, in particular involving the use of memory, concurrency and interaction
- be able use the Haskell stack build tool and understand the mechanisms of package management
- appreciate the importance of functional abstraction for conciseness and efficiency of programming complex applications
- be familiar with the second-order polymorphic lambda calculus (Hindley-Milner predicative let-polymorphism, impredicative System F) as an operational semantics behind (eager, lazy) functional programming
- be able to explain the encoding of recursive data structures in type theory
- have an elementary understanding of the execution model of functional languages and transformation to operational code through defunctionalisation and abstract machines.
- by able to use FP (specifically Haskell) as a development tool for the design of new programming languages

Remark:

The workload for this module splits up roughly like this:

- participation in lectures and tutorials: 45 hrs
- preparation of classes and tutorials as well literature research: 60 hrs
- solving (ungraded) programming exercises and participation in lab sessions: 45 hrs
- exam preparation: 30 hrs

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
Elementary programming skills in a functional programming language, such as from module GdI-IFP-B; Basic knowledge in the use of	none

temporal and modal logic specification formalisms such as from GdI-MTL-B. English language skills at Level B2 (UniCert II) or above. Module Introduction to Functional Programming (GdI-IFP-M) - recommended		
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Advanced Functional Programming — **2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Lecturers: Prof. Ph.D. Michael Mendler
Language: English/German
Frequency: every summer semester

Contents:
Through class presentations and direct interactions with the students the lecturer introduces the topics of the course in detail, poses exercises and suggests literature for self-study.

Literature:

- S. Marlow: The Haskell 2010 Language Report. https://www.haskell.org/onlinereport/haskell2010/
- V. Zsók, Z. Horváth, R. Plasmeijer: Central European Functional Programming School. Springer 2012.
- S. Marlow: Parallel and Concurrent Programming in Haskell: Techniques for Multicore and Multithreaded Programming, O'Reilly 2013.
- B. O'Sullivan, J. Goerzen, D. Stewart: Real World Haskell. O'Reilly 2009.
- Ch. Okasaki: Purely Functional Data Structures, CUP 1998
- F. Rabhi, G. Lapalme: Algorithms - A Functional Approach.
- D. Syme, A. Granicz, A. Cisternino: Expert F#4.0, Apress 2015.
- B. Pierce: Types and Programming Languages. MIT Press 2002. (esp. Chapters 23+25)
- H. Barendregt, W. Dekkers, R. Statman: Lambda Calculus with Types. CUP 2013.

2. Functional Programming of Reactive Systems — **2,00 Weekly Contact Hours**

Mode of Delivery: Practicals
Lecturers: Prof. Ph.D. Michael Mendler
Language: English/German
Frequency: every summer semester

Contents:
The tutorials deepen the students' understanding of the theoretical concepts and constructions covered in the lectures through practical exercises. Participants are given the opportunity to discuss their solutions to homework question sheets and sample solutions are presented by the tutors or lecturer for selected exercises. The tutorials also provide exam preparation.

Literature:

The literature will be announced in class. Here are some general pointers on FP languages and synchronous programming. • S. Marlow: The Haskell 2010 Language Report. https://www.haskell.org/onlinereport/haskell2010/ • V. Zsók, Z. Horváth, R. Plasmeijer: Central European Functional Programming School. Springer 2012. • S. Marlow: Parallel and Concurrent Programming in Haskell: Techniques for Multicore and Multithreaded Programming, O'Reilly 2013. • D. Syme, A. Granicz, A. Cisternino: Expert F#4.0, Apress 2015. • H. Barendregt, W. Dekkers, R. Statman: Lambda Calculus with Types. CUP 2013. • Benveniste, A. et al: The Synchronous Languages 12 years later. Proc. IEEE, Vol 91(1), January 2003. • Berry, G.: SCADE: Synchronous design and validation of embedded control software. In: Next Generation Design and Verification Methodologies for Distributed Embedded Control Systems. Proc. GM R&D Workshop, Bangalore, January 2007. pp. 19-33. • Potop-Butucaru et. al: The Synchronous Hypothesis and Synchronous Languages. In Richard Zurawski. *Embedded Systems Design and Verification*, CRC Press, pp.6-1-6-27, 2009.	
Examination Written examination / Duration of Examination: 90 minutes **Description:** The examination language is English. The form of examination is either oral (30 minutes) or written (90 minutes) depending on the number of participants. The form of examination will be determined at the beginning of the semester and announced in class.	

Examination Oral examination / Duration of Examination: 30 minutes **Description:** The examination language is English. The form of examination is either oral (30 minutes) or written (90 minutes) depending on the number of participants. The form of examination will be determined at the beginning of the semester and announced in class.	

Module GdI-GTI-B Machines and Languages *Grundlagen der Theoretischen Informatik*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Isolde Adler	
Contents: This course addresses the questions "what is a computation?" and "what is an algorithm?" and explores the capabilities and limitations of computers and programming languages as well as the implication of these for a practical computer scientist. It introduces the basic concepts and methods that underlie the mathematical study of computing machines and formal languages.	
Learning outcomes: At the end of this course the students should be able to distinguish finite automata, pushdown automata, Turing machines, and know the difference between the deterministic and non-deterministic versions in each case; be able to distinguish regular, context-free, context-sensitive and general phrase structure grammars in the Chomsky Hierarchy; understand the relations between language classes and machine classes; have developed elementary automata and Turing machine programming skills; know the basic concepts of algorithmic complexity theory such as the big-O notation and key complexity classes such as N and NP as well as their relationship.	
Remark: The language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.	
prerequisites for the module: None.	
Recommended prior knowledge: Elementary concepts in logic and discrete mathematics for computer scientists; Basic programming skills; English language skills at Level B2 (UniCert II) or above.	**Admission requirements:** None.
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Machines and Languages **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Isolde Adler **Language:** German/English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: Through prepared class presentations and direct interactions with the students the lecturer introduces the topics of the course in detail, poses exercises and suggests literature for self-study.	
Literature: • Hopcroft, J. E., Motwani, R., Ullman, J. D.: Introduction to Automata Theory, Languages, and Computation. Addison Wesley, 2001.	

- Martin, J. C.: Introduction to Languages and the Theory of Computation, McGraw Hill, (2nd ed.), 1997.
- Sudkamp, Th. A.: Languages and Machines. An Introduction to the Theory of Computer Science. Addison Wesley, (2nd ed.) 1997.

2. Machines and Languages

Mode of Delivery: Practicals

Lecturers: Prof. Dr. Isolde Adler, N.N.

Language: German/English

Frequency: every summer semester

2,00 Weekly Contact Hours

Contents:

The tutorials deepen the students' understanding of the theoretical concepts and constructions covered in the lectures through practical exercises. Participants are given the opportunity to present their solutions to homework question sheets and sample solutions are given by the lecturer for selected exercises. The tutorials also provide exam preparation.

Examination

No type selected

Module GdI-IFP-M Introduction to Functional Programming *Introduction to Functional Programming*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Ph.D. Michael Mendler	
Contents: The aim of this module is to provide an introduction to functional programming using Haskell. This course develops both elementary practical programming skills and discusses the typed lambda calculus and its role as an operational semantics for functional programming, stressing the importance of types and type checking for static program analysis.	
Learning outcomes: At the end of this course students should be familiar with important language constructs of Haskell and their semantics (e.g., expressions, local declarations, higher-order function abstraction, recursion, lazy and eager evaluation, referential transparency, algebraic data types, monads); be able to use these language concepts to solve algorithmic problems; be familiar with the lambda calculus as an operational semantics behind functional programming; understand the difference between imperative and declarative programming styles; have an appreciation of the close relationship between programming language types and specification and the role of type checking as a static program analysis method; be familiar with polymorphic Hindley-Milner style type systems.	
Remark: The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German.	
prerequisites for the module: none	
Recommended prior knowledge: Elementary concepts in logic and discrete mathematics for computer scientists; Basic programming skills; English language skills at Level B2 (UniCert II) or above.	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Introduction to Functional Programming **Mode of Delivery:** Lectures **Lecturers:** Prof. Ph.D. Michael Mendler **Language:** English/German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: Through prepared class presentations and direct interactions with the students the lecturer introduces the topics of the course in detail, poses exercises and suggests literature for self-study.	
Literature: • Pierce, B. C.: Types and Programming Languages, MIT Press, 2002	

• Thompson, S.: Haskell – The Craft of Functional Programming, Addison-Wesley 1999.	
2. Introduction to Functional Programming **Mode of Delivery:** Practicals **Lecturers:** Prof. Ph.D. Michael Mendler **Language:** English/German **Frequency:** every winter semester **Contents:** The tutorials deepen the students' understanding of the theoretical concepts and constructions covered in the lectures through practical exercises. Participants are given the opportunity to discuss their solutions to homework question sheets and sample solutions are presented by the tutors or lecturer for selected exercises. The tutorials also provide exam preparation.	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** 90 min written examination. The exam takes place during the regular exam period after the end of the semester.	

Module GdI-MTL-B Modal and Temporal Logic *Modal and Temporal Logic*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Ph.D. Michael Mendler	
Contents: This advanced module aims to give a thorough introduction to a selection of modal logics with strong applications in Computer Science. Basic knowledge of classical propositional logic and predicate logic and associated calculi is assumed as a prerequisite. Among the logics covered are modal and temporal logics for the analysis of distributed systems or semantic information processing. Depending on the time available, the module also covers belief logics and other specialised logics for security protocols and distributed algorithms. The course addresses theoretical foundations (models and proof systems) but also discusses applications and offers practical experience through hands-on experimentation with automatic and interactive verification tools.	
Learning outcomes: At the end of the course students should understand the commonalities and differences between propositional and predicate logics on the one hand and modal logics on the other for system specification and modelling; be aware of the important role played by modal logics for the trade-off between expressiveness and automation; know the semantical foundations of modal logics based on Kripke structures; understand the difference between epistemic, temporal, deontic modalities; be familiar with basic results from modal correpondence theory with modal theories such as K, S4, S5; know the Hennessy-Milner Theorem, model filtration and minimzation techniques; apply standard reasoning procedures based on Hilbert, Gentzen Sequent and Tableau calculi; be familiar with the syntax and semantics of important temporal logics such as PLTL, CTL and description logics such as ALC; be able to apply deduction and model-checking techniques for the specification and verification of distributed and dynamic systems as well as semantic information processing.	
Remark: The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German.	
prerequisites for the module: none	
Recommended prior knowledge: Elemantary logic and discrete mathematics for computer scientists; Basic programming skills. Module Discrete Modelling (Inf-DM-B) - recommended Module Logic and Computability (Inf-LBR-B) - recommended	**Admission requirements:** none
Frequency: every winter semester / **Recommended semester:** / **Minimal Duration of the Module:** 1 Semester	

Module Units	
Modal and Temporal Logic **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Ph.D. Michael Mendler **Language:** English/German	**4,00 Weekly Contact Hours**

Frequency: every winter semester

Contents:

Through prepared class presentations and direct interactions with the students the lecturer introduces the topics of the course in detail, poses exercises and suggests literature for self-study.

Literature:

- Fagin, R., Halpern, J. Y., Moses, Y., Vardi, M. Y.: Reasoning about Knowledge. MIT Press, (2nd printing) 1996.
- Hughes, G. E., Cresswell, M. J.: A New Introduction to Modal Logic. Routledge, (3rd reprint) 2003.
- Popkorn, S.: First Steps in Modal Logic. Cambridge University Press, 1994.
- Baader, F., Calvanese, D., McGuinness, D.L., Nardi, D., Patel-Schneider, P.F. (eds): The Description Logic Handbook: Theory, Implementation and Applications. Cambridge University Press, (2nd ed.) 2007.

Examination

Oral examination

Description:

The examination language is English.

The form of examination is either oral (30 minutes) or written (90 minutes) depending on the number of participants. The form of examination will be determined at the beginning of the semester and announced in class.

Module HCI-DFM-M Design and Research Methods of Human-Computer Interaction *Design- und Forschungsmethoden der Mensch-Computer-Interaktion*	6 ECTS / 180 h
(since SS24) Person responsible for module: Prof. Dr. Tom Gross	
Contents: Advanced theoretical, methodological, and practical foundation of Human-Computer Interaction	
Learning outcomes: The aim of this module is to teach advanced knowledge and skills in the area of human-computer interaction as well as a broad theoretical and practical methodological expertise concerned with the design, conception, and evaluation of ubiquitous systems. Students of this course learn the relevant literature and systems in breadth and depth and are later able to critical review new literature and systems.	
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lectures and assignments: 45 hours • Credits of the lecture (incl. research and study of additional sources): ca. 30 hours • Credits of the assignments (incl. research and study of additional sources, but without optional homework assignment): ca. 30 hours • Solving the optional homework assignments: overall ca. 45 hours • Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material) The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.	
prerequisites for the module: none	
Recommended prior knowledge: Module Algorithms and data structures (MI-AuD-B) Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B)	**Admission requirements:** Passing the written exam

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human - Computer Interaction **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tom Gross **Language:** German/English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: After an introduction into the subject the following topics are covered in this lecture:	

- Mobile human-computer interaction
- Adaptivity and adaptibility
- Information visualisation
- Tangible user interaction
- Usability engineering
- Usability and economics

Literature:
The course is based on a compilation of different sources; as additional sources and as a reference are recommended:

- Jacko, J.A. and Sears, A., (Eds.). Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications. Lawrence Erlbaum, Hillsdale, NJ, 2002.
- Hammond, J., Gross, T. and Wesson, J., (Eds.). Usability: Gaining a Competitive Edge. Kluwer Academic Publishers, Dordrecht, 2002.

Examination
Oral examination
Description:
The oral exam takes 30 minutes and is worth a total of 90 points. Depending on the number of attendees the form of the exam can be changed to a written exam with 90 minutes and a total of 90 points. The final form of the exam is announced in the first lecture at the beginning of the term.

During the semester students can do assignments, which are optional. They are 12 points in total. The type of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the oral exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the oral exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.

Module Units

Human-Computer Interaction — **2,00 Weekly Contact Hours**
Mode of Delivery: Practicals
Lecturers: Scientific Staff Mensch-Computer-Interaktion
Language: German/English
Frequency: every summer semester

Contents:
Practical assignments based on the subjects of the lecture.

Literature:
Cf. lecture

Examination
Written examination / Duration of Examination: 90 minutes
Description:

In Abhängigkeit von der Teilnehmerzahl wird die Modulprüfung entweder in Form einer Klausur oder in Form einer mündlichen Prüfung durchgeführt. Die Festlegung erfolgt zu Semesterbeginn und wird im ersten Lehrveranstaltungstermin bekannt gegeben. In der Klausur über 90 min. können 90 Punkte erzielt werden. Es besteht die Möglichkeit, optionale Studienleistungen zu erbringen. Diese umfassen insgesamt 12 Punkte. Die Art der optionalen Studienleistungen sowie deren Bearbeitungsfrist werden zu Beginn der Lehrveranstaltung verbindlich bekannt gegeben. Ist die Prüfung bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die durch optionale Studienleistungen erreichten Punkte als Bonuspunkte angerechnet. Eine 1,0 ist in der Prüfung auf jeden Fall auch ohne Punkte aus der Bearbeitung optionaler Studienleistungen erreichbar.	

Module HCI-DISTP-B Design of Interactive Systems: Theory and Practice *Design Interaktiver Systeme: Theorie und Praxis*	6 ECTS / 180 h
(since SS24) Person responsible for module: Prof. Dr. Tom Gross	
Contents: Theoretical, methodical, practical foundation of design and practical design with focus on a research challenge.	
Learning outcomes: The aim of this module is a general introduction to basic practical skills, processes, and methods of design with a special application-oriented focus on the user-centred design of complex interactive systems.	
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lecture units • Participation in the group meetings • Work on the tasks alone and with the team • Preparation of discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the task definitions and the joint coordination of tasks in the team The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English	
prerequisites for the module: none	
Recommended prior knowledge: none	**Admission requirements:**
Frequency: every summer semester / **Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Design of Interactive Systems: Theory and Practice **Mode of Delivery:** Lectures and Practicals **Lecturers:** Jochen Denzinger **Language:** German/English **Frequency:** every summer semester	**1,00 Weekly Contact Hours**
Contents: In this lecture the following topics are covered: • Design theory and history • Design of multimodal user interfaces • User-Centred Design, User-Experience Design • Practical design, incl. practical application of methods for the iterative design	

The assignements cover diverse topics based on the contents of the course. The practical part includes an iterative design as an assignment. The task is significantly more comprehensive than the normal assignments accompanying the lectures and therefore is solved in a small group. The results are documented and demonstrated in a final presentation. **Literature:** The course is based on a compilation of different sources; as additional sources and as a reference are recommended: • Krippendorff, K. The Semantic Turn. A New Foundation for Design. Taylor & Francis Group, Boca Raton, FL, 2006. • Moggridge, B. Designing Interactions. MIT Press, Cambridge, MA, 2007.	
Examination Colloquium / Duration of Examination: 30 minutes **Description:** Colloquium on the assignment process and results	

Module Units	
Reflexion zum Design interaktiver Systeme: Theorie und Praxis **Mode of Delivery:** Practicals **Lecturers:** Jochen Denzinger **Language:** German/English **Frequency:** every summer semester **Contents:** In der Übung erlernen die Studierenden die kritische Reflexion der eigenen Bearbeitung der wechselnden Aufgaben zu den Inhalten der Lehrveranstaltung im Rahmen des eigenen iterativen Entwurfs. **Literature:** Die Veranstaltung ist eine Zusammenstellung verschiedener Quellen	**1,00 Weekly Contact Hours**

Examination Colloquium / Duration of Examination: 30 minutes **Description:** Kolloquium zum Übungsverlauf und Übungsergebnissen	

Module HCI-DR-M Design Research *Design-Forschung*		6 ECTS / 180 h
(since SS24) Person responsible for module: Prof. Dr. Tom Gross		
Contents: Theoretical, methodical, practical foundation of design and practical design with focus on a research challenge.		
Learning outcomes: The aim of this module is a general introduction to basic practical skills, processes, and methods of design with a special application-oriented focus on the user-centred design of complex interactive systems.		
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lecture units • Participation in the group meetings • Work on the tasks alone and with the team • Preparation of discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the task definitions and the joint coordination of tasks in the team The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English		
prerequisites for the module: none		
Recommended prior knowledge: Es wird empfohlen, zunächst Module des Grundlagenbereichs der Modulgruppe A2 Design zu absolvieren, bevor dieses Modul des Vertiefungsbereichs belegt wird.		**Admission requirements:**
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Design of Interactive Systems: Theory and Practice **Mode of Delivery:** Lectures and Practicals **Lecturers:** Stephan Ott **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: In this lecture the following topics are covered: • Design theory and history • Design of multimodal user interfaces • User-Centred Design, User-Experience Design	

• Practical design, incl. practical application of methods for the iterative design The assignements cover diverse topics based on the contents of the course. The practical part includes an iterative design as an assignment. The task is significantly more comprehensive than the normal assignments accompanying the lectures and therefore is solved in a small group. The results are documented and demonstrated in a final presentation. **Literature:** The course is based on a compilation of different sources; as additional sources and as a reference are recommended: • Krippendorff, K. The Semantic Turn. A New Foundation for Design. Taylor & Francis Group, Boca Raton, FL, 2006. • Moggridge, B. Designing Interactions. MIT Press, Cambridge, MA, 2007.	
Examination Colloquium / Duration of Examination: 30 minutes **Description:** Colloquium on the assignment process and results	

Module HCI-IS-B Interactive Systems *Interaktive Systeme*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since SS23) Person responsible for module: Prof. Dr. Tom Gross	
Contents: Theoretical, methodological, and practical foundation of Human-Computer Interaction	
Learning outcomes: The aim of this module is a general introduction to fundamental paradigms, concepts, and principles of user interface design. The primary focus is on the conceptual design, the implementation, and the evaluation of interactive systems	
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lectures and assignments: 45 hours • Preparation and postprocessing of the lecture (incl. research and study of additional sources): ca. 30 hours • Preparation and postprocessing of the assignments (incl. research and study of additional sources, but without homework assignment): ca. 30 hours • Solving the optional homework assignments: overall ca. 45 hours • Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material) The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English	
prerequisites for the module: none	
Recommended prior knowledge: Basic knowledge in computer science to the extent of an introduction to computer science	**Admission requirements:** Passing the exam
Frequency: every winter semester / **Recommended semester:** / **Minimal Duration of the Module:** 1 Semester	

Module Units	
1. Interactive Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tom Gross **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: In this lecture the following topics are covered: • Introduction to the design of user interfaces • Human factors • Technological factors	

• Interaction, design, prototyping, and implementation • Evaluation of interactive systems • Design process of interactive systems • Interactive systems in a broader context and related topics **Literature:** The course is based on a compilation of different sources; as additional sources and as a reference are recommended: • Preece, J., Rogers, Y. and Sharp, H. Interaction Design: Beyond Human-Computer Interaction. Wiley, New York, NY, 3rd Edition, 2011. • Dix, A., Finlay, J., Abowd, G.D. and Beale, R. Human-Computer Interaction. Pearson, Englewood Cliffs, NJ, 3rd Edition, 2004.	
2. Interactive Systems **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every winter semester **Contents:** Practical assignments based on the subjects of the lecture including the programming of small prototypes **Literature:** Cf. lecture	**2,00 Weekly Contact Hours**
Examination Written examination / Duration of Examination: 90 minutes **Description:** The written exam is worth a total of 90 points During the semester students can do assignments, which are optional. They are 12 points in total. The type, effort and amount of points of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the written exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the written exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.	

Examination Oral examination **Description:** In Abhängigkeit der Teilnehmerzahl wird die Modulprüfung entweder in Form einer Klausur oder in Form einer mündlichen Prüfung durchgeführt. Die Festlegung erfolgt zu Semesterbeginn und wird im ersten Lehrveranstaltungstermin bekannt gegeben. In der mündlichen Prüfung können 90 Punkte erzielt werden. Die Prüfungsdauer wird im ersten Veranstaltungstermin mitgeteilt.	

Es besteht die Möglichkeit, optionale Studienleistungen zu erbringen. Diese umfassen insgesamt 12 Punkte. Die Art der optionalen Studienleistungen sowie deren Bearbeitungsfrist werden zu Beginn der Lehrveranstaltung verbindlich bekannt gegeben. Ist die Prüfung bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die durch optionale Studienleistungen erreichten Punkte als Bonuspunkte angerechnet. Eine 1,0 ist in der Prüfung auf jeden Fall auch ohne Punkte aus der Bearbeitung optionaler Studienleistungen erreichbar.	

Module HCI-KS-B Cooperative Systems *Kooperative Systeme*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Tom Gross	
Contents: Theoretical, methodological, and practical foundation of Computer-Supported Cooperative Work.	
Learning outcomes: The aim of this module is to teach advanced paradigms and concepts of computer-supported cooperative work (CSCW) and the resulting design principles and prototypes. Hereby a broad perspective on the topic is applied; accordingly a central concern is the general technological support of social interaction, spanning cooperative work and learning as well as leisure activities.	
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lectures and assignments: 45 hours • Credits of the lecture (incl. research and study of additional sources): ca. 30 hours • Credits of the assignments (incl. research and study of additional sources, but without optional homework assignment): ca. 30 hours • Solving the optional homework assignments: overall ca. 45 hours • Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material) The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English	
prerequisites for the module: none	

Recommended prior knowledge: Basic knowledge in computer science to the extent of an introduction to algorithms, programming and software, as well as programming skills in Java.		**Admission requirements:** Passing the written exam
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Cooperative Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tom Gross **Language:** German/English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: After an introduction into the subject the following topics are covered in this lecture: • Basic concepts	

- Technological support for mutual awareness, communication, coordination, collaboration, and online communities
- Analysis of cooperative environments
- Design of CSCW and groupware systems
- Implementation of CSCW and groupware systems
- CSCW in a broader context and related topics

Literature:
The course is based on a compilation of different sources; as additional sources and as a reference are recommended:

- Gross, T. and Koch, M. Computer-Supported Cooperative Work (Computer-Supported Cooperative Work; in German). Oldenbourg, Munich, 2007.
- Borghoff, U.M. and Schlichter, J.H. Computer-Supported Cooperative Work: Introduction to Distributed Applications. Springer-Verlag, Heidelberg, 2000.

Examination
Oral examination
Description:
The oral exam takes 30 minutes and is worth a total of 90 points. Depending on the number of attendees the form of the exam can be changed to a written exam with 90 minutes and a total of 90 points. The final form of the exam is announced in the first lecture at the beginning of the term.

During the semester students can do assignments, which are optional. They are 12 points in total. The type of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the oral exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the oral exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.

Module Units

Cooperative Systems — **2,00 Weekly Contact Hours**
Mode of Delivery: Practicals
Lecturers: Scientific Staff Mensch-Computer-Interaktion
Language: German/English
Frequency: every summer semester

Contents:
Practical assignments based on the subjects of the lecture including the programming of small prototypes

Literature:
Cf. lecture

Examination
Written examination / Duration of Examination: 90 minutes
Description:

In Abhängigkeit der Teilnehmerzahl wird die Modulprüfung entweder in Form einer Klausur oder in Form einer mündlichen Prüfung durchgeführt. Die Festlegung erfolgt zu Semesterbeginn und wird im ersten Lehrveranstaltungstermin bekannt gegeben. In der Klausur über 90 min. können 90 Punkte erzielt werden. Es besteht die Möglichkeit, optionale Studienleistungen zu erbringen. Diese umfassen insgesamt 12 Punkte. Die Art der optionalen Studienleistungen sowie deren Bearbeitungsfrist werden zu Beginn der Lehrveranstaltung verbindlich bekannt gegeben. Ist die Prüfung bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die durch optionale Studienleistungen erreichten Punkte als Bonuspunkte angerechnet. Eine 1,0 ist in der Prüfung auf jeden Fall auch ohne Punkte aus der Bearbeitung optionaler Studienleistungen erreichbar.	

Module HCI-MCI-M Human-Computer Interaction *Mensch-Computer-Interaktion*	6 ECTS / 180 h
(since WS21/22) Person responsible for module: Prof. Dr. Tom Gross	
Contents: Advanced theoretical, methodological, and practical foundation of Human-Computer Interaction	
Learning outcomes: The aim of this module is to teach advanced knowledge and skills in the area of human-computer interaction as well as a broad theoretical and practical methodological expertise concerned with the design, conception, and evaluation of ubiquitous systems. Students of this course learn the relevant literature and systems in breadth and depth and are later able to critical review new literature and systems.	
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lectures and assignments: 45 hours • Credits of the lecture (incl. research and study of additional sources): ca. 30 hours • Credits of the assignments (incl. research and study of additional sources, but without optional homework assignment): ca. 30 hours • Solving the optional homework assignments: overall ca. 45 hours • Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material) The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.	
prerequisites for the module: none	
Recommended prior knowledge: Module Algorithms and data structures (MI-AuD-B) Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B)	**Admission requirements:** Passing the written exam

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Human - Computer Interaction **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tom Gross **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: After an introduction into the subject the following topics are covered in this lecture: • Mobile human-computer interaction	

- Adaptivity and adaptibility
- Information visualisation
- Tangible user interaction
- Usability engineering
- Usability and economics

Literature:
The course is based on a compilation of different sources; as additional sources and as a reference are recommended:

- Jacko, J.A. and Sears, A., (Eds.). Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies, and Emerging Applications. Lawrence Erlbaum, Hillsdale, NJ, 2002.
- Hammond, J., Gross, T. and Wesson, J., (Eds.). Usability: Gaining a Competitive Edge. Kluwer Academic Publishers, Dordrecht, 2002.

Examination
Oral examination
Description:
The oral exam takes 30 minutes and is worth a total of 90 points. Depending on the number of attendees the form of the exam can be changed to a written exam with 90 minutes and a total of 90 points. The final form of the exam is announced in the first lecture at the beginning of the term.

During the semester students can do assignments, which are optional. They are 12 points in total. The type of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the oral exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the oral exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.

Module Units

Human-Computer Interaction — **2,00 Weekly Contact Hours**
Mode of Delivery: Practicals
Lecturers: Scientific Staff Mensch-Computer-Interaktion
Language: German/English
Frequency: every winter semester

Contents:
Practical assignments based on the subjects of the lecture.

Literature:
Cf. lecture

Examination
Written examination / Duration of Examination: 90 minutes
Description:
In Abhängigkeit der Teilnehmerzahl wird die Modulprüfung entweder in Form einer Klausur oder in Form einer mündlichen Prüfung durchgeführt.

Die Festlegung erfolgt zu Semesterbeginn und wird im ersten Lehrveranstaltungstermin bekannt gegeben. In der Klausur über 90 Min. können 90 Punkte erzielt werden. Es besteht die Möglichkeit, optionale Studienleistungen zu erbringen. Diese umfassen insgesamt 12 Punkte. Die Art der optionalen Studienleistungen sowie deren Bearbeitungsfrist werden zu Beginn der Lehrveranstaltung verbindlich bekannt gegeben. Ist die Prüfung bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die durch optionale Studienleistungen erreichten Punkte als Bonuspunkte angerechnet. Eine 1,0 ist in der Prüfung auf jeden Fall auch ohne Punkte aus der Bearbeitung optionaler Studienleistungen erreichbar.	

Module HCI-US-B Ubiquitous Systems *Ubiquitäre Systeme*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Tom Gross	
Contents: Theoretical, methodological, and practical foundation of Ubiquitous Computing	
Learning outcomes: The aim of this module is to teach advanced knowledge and skills in the aerea of ubiquitous systems as well as abroad theoretical and practical methodological expertise concerned with the design, conception and evaluation of ubiquitous systems. Students of this course learn the relevant literature and systems in breadth and depth and should be able to critical review new litarature and systems	
Remark: htp://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Attendance of the lectures and assignments: 45 hours • Credits of the lecture (incl.research and study of additional sources): ca. 30 Hours • Credits of the assignments ((incl.research and study of additional sources, excluding optional homework assignment): ca. 30 hours • Solving the optional homework assignments: overall ca. 45 hours • Exam preparation: ca. 30 hours (based on the above mentioned preparation and revision of the subject material) The default language of instruction in this course is German, but can be changed to English on demand. All course materials (incl. exams) are available in English.	
prerequisites for the module: none	
Recommended prior knowledge: Module Algorithms and data structures (MI-AuD-B) Module Introduction to Algorithms, Programming and Software (DSG-EiAPS-B)	**Admission requirements:** Passing the written exam

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Ubiquitous Systems **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tom Gross **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: This lecture gives an introduction to the subject of Ubiquitous Computing—that is, the paradigm of invisible computing, with computers embedded into everyday objects that act as client and server and communicate with each other—and includes the following conceptual, technical and methodological topics:	

- Basic concepts
- Base technology and infrastructures
- Ubiquitous systems and prototypes
- Context awareness
- User interaction
- Ubiquitous systems in a broad context and related topics

Literature:
The course is based on a compilation of different sources; as additional sources and as a reference are recommended:

- Krumm, J. (Ed.). Ubiquitous Computing Fundamentals. Taylor & Francis Group, Boca Raton, FL, 2010.

Examination
Oral examination
Description:
The oral exam takes 30 minutes and is worth a total of 90 points. Depending on the number of attendees the form of the exam can be changed to a written exam with 90 minutes and a total of 90 points. The final form of the exam is announced in the first lecture at the beginning of the term.

During the semester students can do assignments, which are optional. They are 12 points in total. The type of optional homework assignments as well as the deadlines are announced in detail at the beginning of the term. If the oral exam is passed (as a rule 50% of the points have to be reached) the points from the assignments are a bonus and added to the points from the oral exam. In any case, a top grade of 1,0 is also reachable without solving the assignments.

Module Units

Ubiquitous Systems — **2,00 Weekly Contact Hours**
Mode of Delivery: Practicals
Lecturers: Scientific Staff Mensch-Computer-Interaktion
Language: German/English
Frequency: every winter semester

Contents:
Practical assignments based on the subjects of the lecture including the programming of small prototypes

Literature:
Cf. lecture

Examination
Written examination / Duration of Examination: 90 minutes
Description:
In Abhängigkeit der Teilnehmerzahl wird die Modulprüfung entweder in Form einer Klausur oder in Form einer mündlichen Prüfung durchgeführt.

Die Festlegung erfolgt zu Semesterbeginn und wird im ersten Lehrveranstaltungstermin bekannt gegeben. In der Klausur über 90 min. können 90 Punkte erzielt werden. Es besteht die Möglichkeit, optionale Studienleistungen zu erbringen. Diese umfassen insgesamt 12 Punkte. Die Art der optionalen Studienleistungen sowie deren Bearbeitungsfrist werden zu Beginn der Lehrveranstaltung verbindlich bekannt gegeben. Ist die Prüfung bestanden (in der Regel sind hierzu 50 % der Punkte erforderlich), so werden die durch optionale Studienleistungen erreichten Punkte als Bonuspunkte angerechnet. Eine 1,0 ist in der Prüfung auf jeden Fall auch ohne Punkte aus der Bearbeitung optionaler Studienleistungen erreichbar.	

Module HCI-Usab-M Usability in Practice *Usability in der Praxis*	6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tom Gross	
Contents: Practical work on a real-world topic of Human-Computer Interaction.	
Learning outcomes: In this course the knowledge and skills obtained in the human-computer interaction lectures and assignments are applied in practice. Based on real use cases from industry contexts students will analyse the usability of existing concepts and systems and gather requirements for innovative concepts. Central to this course is the development of skills regarding the practical application of methods as well as competencies regarding project management and teamwork.	
Remark: http://www.uni-bamberg.de/hci/leistungen/studium The workload for this module is roughly structured as following: • Participation in the kick-off meeting • Participation in the group meetings • Work on the tasks alone and with the team • Preparation of discussions and presentation • Exam preparation The workload for each participant may vary over the different tasks based on the task definitions and the joint coordination of tasks in the team The default language of instruction is German and can be changed to English based on students' needs. All course materials (incl. exams) are available in English	
prerequisites for the module: none	
Recommended prior knowledge: Module Human-Computer Interaction (HCI-MCI-M)	**Admission requirements:** Passing the exam

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Usability in der Praxis **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Tom Gross, Scientific Staff Mensch-Computer-Interaktion **Language:** German/English **Frequency:** every summer semester	**4,00 Weekly Contact Hours**
Contents: The course covers diverse topics from human-computer interaction that are cooperatively solved with companies. They typically range from specifying challenges to selecting and applying methods as well as analysing the captured data to deriving conclusions. The task is significantly more comprehensive than	

the normal assignments accompanying the lectures and therefore is solved in a small group. The results are documented and demonstrated in a final presentation. **Literature:** To be announced in the course	
Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Documentation on the project process and results as well as colloquium on the project process and results.	

Module ISDL-DEXP-B Digital Experimentation *Digital Experimentation*	6 ECTS / 180 h

Person responsible for module: Dr. Christoph Weinert

Contents:

***** Modul wird im Wintersemester 2025/2026 NICHT angeboten. *****

Durch das Internet kamen sogenannte Online-Experiment auf, die gerade von großen Tech-Konzernen wie Google, Facebook oder Alibaba genutzt werden, um Produkte und Dienstleistungen zu evaluieren. Darüber hinaus können Experimente dabei helfen

sozialen und wirtschaftlichen Aktivitäten, an denen sich Menschen online beteiligen besser zu verstehen. Das liegt daran, dass Experimente sowohl in der Forschung als auch in der Praxis eine exzellente Möglichkeit sind, um Reiz-Reaktions-Beziehungen abzubilden und untersuchen zu können. In einem Experiment wird ein Reiz bewusst manipuliert, um die darauffolgenden Reaktionen messen zu können während die Kontextvariablen stabil gehalten oder kontrolliert werden. Die Durchführung von Experimenten hat eine lange Historie in den Naturwissenschaften, allerdings wird diese Methode immer häufiger in die Praxis und Forschung der Wirtschaftsinformatik eingesetzt.

Die Vorlesung gliedert sich ausgehend von generellen Einsatz von Experimenten in Forschung und Praxis bis hin zur konkreten Planung, Aufbau und Durchführung von verschiedenen Arten von Experimenten (z.B. Online-Experimente, Laborexperimente, Feldexperimente).

Learning outcomes:

Das Modul vermittelt ein grundlegendes Verständnis sowie Kenntnisse zu Planung, Aufbau, Durchführung, und Auswertung für verschiedene Arten von Experimenten (z.B. Online-Experimente, Laborexperimente, Feldexperimente). Das Modul befähigt die Teilnehmer zur eigenständigen Durchführung von Experimenten in wissenschaftlichen wie auch praktischen Kontexten.

Remark:

Der Arbeitsaufwand für dieses Modul gliedert sich ungefähr wie folgt:

- Teilnahme an Vorlesung und Übung: insgesamt 42 Stunden
- Vor- und Nachbereitung der Vorlesung und Übung (inkl. Recherche und Studium zusätzlicher Quellen): 56 Stunden
- Bearbeiten der Übungsaufgaben: insgesamt 40 Stunden
- Prüfungsvorbereitung ink. Prüfung: 42 Stunden (basierend auf dem bereits im obigen Sinne erarbeiteten Stoff)

prerequisites for the module:

keine

Recommended prior knowledge: keine		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Experimentelle Forschung in der Wirtschaftsinformatik **Mode of Delivery:** Lectures and Practicals **Lecturers:** Dr. Christoph Weinert **Language:** German	**2,00 Weekly Contact Hours**

Frequency: every winter semester

Contents:

Die Inhalte der Vorlesung werden anhand von praktischen Beispielen vertieft. Die Studierenden bekommen die Möglichkeit ein eigenes Experiment zu planen, durchzuführen und auszuwerten. Hierbei werden unter anderem psychologische Tests und objektive Messmethoden (z.B. Eye-tracking, Skin conductance) genutzt.

Literature:

Jarvenpaa, S. L., Dickson, G. W., and DeSanctis, G. 1985. “Methodological Issues in Experimental IS Research: Experiences and Recommendations,” MIS Quarterly (9:2), pp. 141–156.

Karahanna, E., Benbasat, I., Bapna, R., and Rai, A. 2018. “Opportunities and Challenges for Different Types of Online Experiments,” MIS Quarterly (42:4), pp. iii–x.

Weitere Literatur wird in der Vorlesung bekannt gegeben.

Examination

Written examination / Duration of Examination: 90 minutes

prerequisites for module examination:

keine

Description:

In der Klausur werden die in der Vorlesung und Übung behandelten Inhalte geprüft. Es können 90 Punkte erzielt werden. Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen (Planung und Durchführung eines Experiments) können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.

Module ISDL-ISS2-M Optimization of IT-Reliant Processes *Optimierung IT-lastiger Geschäftsprozesse*	6 ECTS / 180 h
(since WS17/18) Person responsible for module: Prof. Dr. Tim Weitzel	
Contents: Content of the module covers theories, models and process models for optimization of IT-focused business processes. The module focuses primarily on the optimization of service provider processes. As a basis for this, the module provides theories and concepts of business process management and specializes in financial and HR processes (these processes are taken as examples for service provider processes). In the framework of the module the parallels to the industrialization of production processes will be discussed and the presented content will be deepened by case studies.	
Learning outcomes: Participants of the session should be able to identify and create optimization potential in IT-intensive business processes in service provider sector. In this context the module focuses on theories, concepts and methodologies of business process management. Here the module conveys analysis and design methods for the development of internal and external optimization, cooperation and sourcing potential.	
Remark: **The language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.**	
prerequisites for the module: none	
Recommended prior knowledge: Keine	**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture: Optimierung IT-lastiger Geschäftsprozesse (ISS2) **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tim Weitzel **Language:** German/English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: The aim of the course is to introduce knowledge and skills to provide optimization of IT-focused business processes. Hereby will be reviewed principles and tools of business process management and their implementation and application into financial and HR processes will be presented. Similarly, approaches to business process optimization through appropriate use of IT will be thematized in the lecture; typical primary and secondary service provider processes will be analyzed in terms of integration, efficiency and effectiveness; goals and methods for optimization will be discussed and process models for optimal process design and change management will be presented.	

Another focal point is a created economics theoretical dispute about the phenomenon, that companies outsource business processes or parts of them to external service providers. The four main areas of this lecture are:

Main focus is on **Business Process Management (BPM).** Design of business processes is one of the core competencies of IS professionals.

Therefore, this lecture focuses on theories, models, tools, and methods of BPM, change management and business process standardization. These BPM concepts will be examined in more detail within the E-Finance, HER and Outsourcing sections. The objective is that students are able to design, standardize, manage and change business processes effectively and efficiently.

E-Finance: Financial processes can be generally considered as completely digitalizable and appear both as primary processes in the financial services industry and as secondary processes in all other firms. The lecture discusses how optimal IT usage can be attained in the financial service industry, which optimization potentials can be uncovered in the financial chain management of non-banks, and which re-structuring alternatives for the value chain by a “value chain crossing” are practical.

E-HR: The IT support of HR management processes is surprisingly low. Therefore, the status quo and additional possibilities for this typical secondary process will be introduced. Particularly, a (partial) automation of the personnel selection process can be realized by employing recommender systems. The lecture will discuss enablers and inhibitors of IT usage in general and in HR in particular.

Sourcing: The questions of which services to be delivered, to where, and by whom, are strategic questions in a BPM context. Advantages and disadvantages, like economies of skill, scale, and scope, will be discussed and decision support models as well as “good practices” of business process outsourcing (BPO), along with problems and cultural barriers, will be examined.

The scientific perspective is introduced and presented by the practice cases from partner companies.

Literature:

- Balaji et al. (2011), IT-led Business Process Reengineering: How Sloan Valve Redesigned it’s New Product Development Process, MIS Quarterly Executive, 10, 2, 81-92
- Borman, M. (2006): Identifying the Factors Motivating and Shaping Cosourcing in the Financial Services Sector, Journal of Information Technology Management, vol.17:3, pp. 11-25
- Davenport (1993), Process Innovation: Reengineering Work Through Information Technology, Harvard Business School Press, Boston

- Davenport, T. The coming commoditization of processes. Harvard Business Review (June 2005), 100–108.
- Dibbern, J.; Goles, T.; Hirschheim, R.; Jayatilaka, B. (2004): Information Systems Outsourcing: A survey and Analysis of the Literature, The DATA BASE for Advances in Information Systems, 35 (4)
- Earl et al. (1995). “Strategies for Business Process Reengineering: Evidence from Field Studies,” Journal of Management Information Systems (12:1), pp. 31–56.
- Eckhardt et al. 2012: Bewerbermanagementsysteme in deutschen Großunternehmen: Wertbeitrag von IKT für dienstleistungsproduzierende Leistungs- und Lenkungssysteme, Zeitschrift für Betriebswirtschaft (ZfB) (Journal of Business Economics)
- Gibson, C. (2003): IT-enabled business change: an approach to understanding and managing risk, MIS Quarterly Executive, 2 (2), 104-115
- Gilson et al. (2005): Creativity and Standardization: Complementary or Conflicting Drivers of Team Effectiveness? Academy of Management Journal, Vol. 48, No. 3, 521-531.
- Goo, J.; Kishore, R.; Rao, H. R.; Nam, K. (2009): The Role of Service Level Agreements in Relational Management of Information Technology Outsourcing: An Empirical Study, MIS Quarterly, Vol. 33 Issue 1, p. 119-145
- Hammer, M. 2007. “The Process Audit,” Harvard Business Review (85:4), pp. 111–123.
- Houy, C.; Fettke, P.; Loos, P.; van der Aalst, W. & Krogstie, J. (2011): Business Process Management in the Large, Business & Information Systems Engineering (3:6), 385-388.
- Lee, I. (2007): An Architecture for a Next-Generation Holistic E-Recruiting System", Communications of the ACM, 50(7)
- Münstermann & Weitzel (2008): What is process standardization?, Proceedings of the 2008 International Conference on Information Resources Management (Conf-IRM), Niagara Falls, Ontario, Canada
- Münstermann, Eckhardt, & Weitzel (2010): The performance impact of business process standardization. In: Business Process Management Journal (16:1), 29-56
- Münstermann, von Stetten, Eckhardt & Laumer (2010b): The Performance Impact of Business Process Standardization - HR Case Study Insights, Management Research Review (33:9), 924-939
- Orlikowski und Hofman (1997), An Improvisational Model for Change Management: The Case of Groupware Technologies, Sloan Management Review, Winter, 11-21
- Palmberg, Klara (2009): Exploring process management: are there any widespread models and definitions? In: The TQM Journal 21 (2), S. 203–215.Dumas, M., La Rosa, M., Mendling, J., and Reijers, H. 2013. Fundamentals of business process management, Berlin, New York: Springer
- Pfaff, D., Skiera, B., and Weitzel, T. (2004): Financial-Chain-Management: Ein generisches Modell zur Identifikation von Verbesserungspotenzialen, WIRTSCHAFTSINFORMATIK (46:2), 107-117

- Reijers at el. (2005), Best practices in business process redesign: an overview and qualitative evaluation of successful redesign heuristics. Omega 33(4), 283–306
- Shaw, D. R., Holland, C. P., Kawalek, P., Snowdon, B. and Warboys B. (2007): "Elements of a business process management system: theory and practice", Business Process Management Journal (13:1), pp. 91-107
- Skiera, B., König, W., Gensler, S., Weitzel, T., Beimborn, D., Blumenberg, S., Franke, J., and Pfaff, D. (2004), Financial Chain Management - Prozessanalyse, Effizienzpotenziale und Outsourcing, Books on Demand, Norderstedt.
- Venkatesh, V. and H. Bala (2008), Technology Acceptance Model 3 and a Re-search Agenda on Interventions. Decision Sciences, 39 (2), p. 273-315.
- Wahrenburg, M.; König, W.; Beimborn, D.; Franke, J.; Gellrich, T.; Hackethal, A.; Holzhäuser, M.; Schwarze, F.; Weitzel, T. (2005): Kreditprozess-Management In: Books on Demand; Norderstedt
- Weitzel (2004): Economics of Standards in Information Networks, Springer Physica, New York.
- Weitzel, T., Eckhardt, A., von Westarp, F., von Stetten, A., Laumer, S., and Kraft, B. (2011): Recruiting 2011, Weka Verlag, Zürich, Schweiz.
- Weitzel, T., Eckhardt, A., Laumer, S. (2009): A Framework for Recruiting IT Talent: Lessons from Siemens, MIS Quarterly Executive (8:4), 123-137
- Weitzel, T., Martin, S., and König, W. (2003): Straight Through Processing auf XML-Basis im Wertpapiergeschäft, WIRTSCHAFTSINFORMATIK (45:4), 409-420
- Zairi, Mohamed (1997): Business process management: a boundary less approach to modern competitiveness. In: Business Process Management Journal 3 (1), S. 64–80.

2. Tutorial: Optimierung IT-lastiger Geschäftsprozesse (ISS2)
Mode of Delivery: Practicals
Lecturers: Scientific Staff Wirtschaftsinformatik, insb. Informationssysteme in Dienstleistungsbereichen
Language: German/English
Frequency: every summer semester

2,00 Weekly Contact Hours

Contents:

The contents of the course will be deepened based on exercises and

case studies. Communication of the content is focused on the exercises

of the approach of "teaching cases". Hereby, the developed case studies will be developed and discussed with students. In addition to the work-up of the lecture content here will be emphasized: communication of soft skills, preparation for students' own application process to achieve and complete a successful management position. Corresponding workshops will be conducted jointly with partners from practice.

Literature:

siehe Vorlesung

Examination Written examination / Duration of Examination: 90 minutes **Description:** In the exam the discussed content of lecture and tutorial will be tested. It is possible to achieve 90 points. During the semester there will be a possibility to process a semester assignment. The results will be assessed and by passed exam (usually achieving 45 points is required), points for the semester assignment will be taken into account by grading for the module. But achieving a 1.0 is possible without the credits for the semester assignment in any case.	

Module ISDL-ISS3-M IT Business Value *IT-Wertschöpfung*	6 ECTS / 180 h

(since WS17/18)
Person responsible for module: Prof. Dr. Tim Weitzel

Contents:
This module covers approaches for leveraging the human and technological IT resources and IT capabilities to create business value and generate a competitive advantage. Basic IT issues like the IT paradox, IT assets, IT strategy, IT architecture, IT governance and IT outsourcing management will be discussed. Using these concepts, practical guidelines for IT management will be illustrated with the help of several real world cases. Particularly in the services industry, IT represents a key production resource, and therefore, the focus of this module will be both on how to determine and how to increase the business value contribution of IT.

A main aspect for high IT effectiveness is the alignment of business and IT both at strategic (goals, plans, …) and at operational level (processes, services, …). Business/IT alignment is considered to be a key issue for academics and practitioners alike, dealing with the question of how the interplay between business and IT units can be put into effect? It will be shown that the superior application of IT is not primarily a technical challenge (choosing the right technology and implementing the right systems) rather than the consideration of an IT/IS portfolio which ensures effective usage and high productivity in the context of particular supported business processes. Based upon this, key techniques for IT management and the valuation of information systems will be introduced.

Learning outcomes:
This module deals with the question to what extent and under which conditions IT contributes to organizational business value. Starting from this broad debate students will learn underlying theories, state-of-the-art concepts and concrete managerial guidelines on how to address the challenge of IT business value in practice. A key objective of the module is to provide the students with an in-depth understanding of managing both the technological and the human IT resources in order to use IT strategically and create measurable business value.

Remark:
The language of instruction in this course is German. However, all course materials (lecture slides and tutorial notes) as well as the exam are available in English.

prerequisites for the module:
none

Recommended prior knowledge: keine		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lecture: IT-Wertschöpfung (ISS3) **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Tim Weitzel **Language:** German/English **Frequency:** every summer semester **Contents:**	**2,00 Weekly Contact Hours**

The lecture covers core issues within the areas IT business value and IT management.

- Theoretical lenses (e.g., Resource-based view, Dynamic Capabilities)
- IT Strategy
- IT Architecture
- IT Governance
- IT Business Alignment
- IT Outsourcing Management
- IT Valuation

Literature:

- Carr, N. (2003): IT Doesn't Matter, in: Harvard Business Review, Vol. 81, No. 5, With Letters to the Editor.
- Chan, Y.E., und Reich, B.H. (2007): IT alignment: what have we learned?, in: Journal of Information Technology, No. 22, pp. 297-315.
- Henderson, B.D. und Venkatraman, N. (1993): Strategic alignment: leveraging information technology for transforming organizations, in: IBM Systems Journal (32:1), pp. 4-16.
- Kohli, R., and Grover, V. (2008): Business Value of IT: An Essay on Expanding Research Directions to Keep up with the Times, in: Journal of the AIS, Vol. 9, No. 1, pp. 23-39.
- Melville, N., Kraemer, K., Gurbaxani, V. (2004): Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value, in: MIS Quarterly (28:2), pp. 283-322.
- Mitra et al. (2011): Measuring IT Performance and Communicating Value, in: MISQ Executive (10:1), pp. 47-59.
- Ross, J.W. (2003): Creating a Strategic IT Architecture Competency: Learning in Stages, in: MISQ Executive (2:1), pp. 31-43.
- Wade, M., und Hulland, J.S. (2004): Review : The Resource-Based View and Information Systems Research: Review, Extension, and Suggestions for Future Research, in: MIS Quarterly (28:1), pp. 107-142.

Weitere Literatur wird in der Veranstaltung bekannt gegeben.

2. Tutorial: IT-Wertschöpfung (ISS3)

2,00 Weekly Contact Hours

Mode of Delivery: Practicals

Lecturers: Scientific Staff Wirtschaftsinformatik, insb. Informationssysteme in Dienstleistungsbereichen

Language: German/English

Frequency: every summer semester

Contents:

The content of the lectures will be discussed based on case studies.

Literature:

siehe Vorlesung

Examination

Written examination / Duration of Examination: 90 minutes

Description: The exam questions cover the content presented and discussed in lecture and tutorial. During the semester, students have the (optional) opportunity to do assignments and get extra points. However, these extra points will only be included into the evaluation if the exam itself is passed without the extra points (45 points or more).	

Module ISHANDS-Change-M Digital Change Management *Digital Change Management*	6 ECTS / 180 h

(since SS24)
Person responsible for module: Prof. Dr. Christian Maier

Contents:
Die digitale Transformation ist für Unternehmen essentiell, um langfristig konkurrenzfähig zu bleiben. Jedoch scheitern viele Transformationsprojekte an dem Widerstand der Belegschaft gegenüber Veränderungen.

Das Modul adressiert diesen Herausforderungen durch die Vermittlung verschiedener Methoden, Instrumente und Theorien. Es beleuchtet unterschiedliche Aspekte der Arbeitssystemtheorie, erforscht das Phänomen der Nutzerakzeptanz und -resistenz und diskutiert wirksame Interventionsstrategien. Zudem wird dargelegt, wie die Reaktionen der MitarbeiterInnen von ihren individuellen Erfahrungen, Persönlichkeitsmerkmalen und spezifischen Aufgabenbereichen beeinflusst werden. Dies hilft, um digitale Transformationsprojekte erfolgreich durchzuführen.

Ein innovatives Element des Kurses ist die Integration einer Planspielsimulation. Diese interaktive Simulation ermöglicht es den Studierenden, das theoretische Wissen praktisch anzuwenden, indem sie in die Rolle eines Change-Managers schlüpfen und den Prozess der digitalen Transformation aktiv begleiten. Ergänzt wird dies durch Einblicke in reale Fallstudien.

Der Kurs zielt darauf ab, Schlüsselfragen der digitalen Transformation zu klären, wie beispielsweise:

- Wie fördert die Arbeitssystemtheorie eine erfolgreiche digitale Transformation?
- Inwiefern ist das IT-Business Alignment für die digitale Transformation entscheidend und wer trägt hierfür die Verantwortung?
- Welche Methoden zur Transformation und Implementierung sind für das Management der digitalen Transformation effektiv?
- Warum entsteht Nutzerwiderstand gegenüber der digitalen Transformation?
- Wie differenzieren sich Nutzerakzeptanz und -widerstand?
- Welche Interventionen sind zur Steuerung der digitalen Transformation effektiv?

Learning outcomes:
Studierende erlangen ein tiefgreifendes Verständnis der komplexen Herausforderungen, die mit der digitalen Transformation verbunden sind. Dies schließt detaillierte Kenntnisse über verschiedene Implementierungsstrategien für digitale Technologien ein, sowie ein Bewusstsein für potenzielle Hindernisse, wie z.B. Widerstände seitens der Mitarbeitenden. Sie lernen spezifische Interventionstechniken, um solche Herausforderungen zu bewältigen. Darüber hinaus erwerben die Studierenden praktische Fähigkeiten in der Steuerung digitaler Veränderungsprojekte. Sie werden vertraut gemacht mit relevanten Managementmethoden und -werkzeugen, um digitale Transformationsprojekte nicht nur effektiv zu planen und zu gestalten, sondern auch erfolgreich umzusetzen. Ziel ist es, ihnen die Fähigkeiten zu vermitteln, digitale Veränderungen in Unternehmen strategisch und operativ zu führen.

Remark:
Alle Lehrmaterialien und Unterlagen für dieses Modul werden in englischer Sprache bereitgestellt. Die Vorlesungen sowie die Übungen werden jedoch in deutscher Sprache durchgeführt, um eine klare und verständliche Wissensvermittlung zu gewährleisten.

Der Gesamtarbeitsaufwand für dieses Modul setzt sich wie folgt zusammen:

- Aktive Teilnahme an Vorlesungen und Übungen: insgesamt etwa 45 Stunden.
- Selbstständige Vor- und Nachbereitung der Vorlesungsinhalte sowie Übungen: ungefähr 90 Stunden.
- Intensive Prüfungsvorbereitung: circa 45 Stunden.

Zusätzlich besteht die Möglichkeit, eine freiwillige Studienleistung zu erbringen, für die maximal 10 Bonuspunkte vergeben werden. Die Teilnahme an der Studienleistung vertieft das Verständnis des Lehrstoffs und trägt zur Verbesserung der Gesamtbewertung des Moduls bei.

Sowohl die Vorlesungen als auch die Übungen sind primär als Präsenzveranstaltungen konzipiert.

prerequisites for the module:
none

Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Digital Change Management — **2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Lecturers: Prof. Dr. Christian Maier
Language: German
Frequency: every summer semester

Contents:
Die Vorlesung thematisiert beispielhaft die folgenden Schwerpunkte:

- Arbeitssystemtheorie
- IT-Business-Alignment
- Prozesse und Phasen des Change-Managements
- Change-Management-Theorien (z.B. Nutzerakzeptanz und -widerstände)
- Change-Management-Strategien und Methoden
- Management von IT-MitarbeiterInnen

Literature:
Jede Vorlesung baut auf aktueller, spezifischer Literatur auf, wie etwa:

- Alter, S. (2013). Work System Theory: Overview of Core Concepts, Extensions, and Challenges for the Future. Journal of the Association for Information Systems, 14 (2), 72-121.
- Bhattacherjee, A., Davis, C. J., Connolly, A. J., & Hikmet, N. (2018). User response to mandatory IT use: a coping theory perspective. European Journal of Information Systems, 27(4), 395–414.
- Kotter, J.P. (2010). Leading Change, Harvard Business Press.
- Laumer, S., Maier, C., Eckhardt, A. & Weitzel, T (2016). Work Routines as an Object of Resistance During Information Systems Implementations: Theoretical Foundation and Empirical Evidence. European Journal of Information Systems, 25, 317–343.
- Negoita, B., Rahrovani, Y., Lapointe, L., & Pinsonneault, A. (2022). Distributed IT championing: A process theory. Journal of Information Technology, 37(1), 2–30.

- Sykes, T. A. (2020). Enterprise System Implementation and Employee Job Outcomes: Understanding the Role of Formal and Informal Support Structures Using the Job Strain Model. MIS Quarterly, 44(4), 2055–2086.
- Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J., & Blegind-Jensen, T. (2021). Unpacking the Difference Between Digital Transformation and IT-Enabled Organizational Transformation. Journal of the Association for Information Systems, 22(1), 102–129.

2. Digital Change Management

2,00 Weekly Contact Hours

Mode of Delivery: Practicals

Lecturers: Scientific Staff Health and Society in the Digital Age

Language: German

Frequency: every summer semester

Contents:

Die Übung diskutiert die in der Vorlesung eingeführten Theorien und Methoden. Mittels Simulationen und Fallstudien werden diese angewandt und detailliert diskutiert.

Literature:

Siehe Vorlesung.

Examination

Written examination / Duration of Examination: 90 minutes

Description:

In der Klausur werden die Lerninhalte, die während der Vorlesungen und Übungen behandelt wurden, geprüft. Insgesamt können in der Klausur bis zu 90 Punkte erreicht werden.

Studierende haben die Möglichkeit, durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen bis zu 10 zusätzliche Punkte zu erlangen. Diese Bonuspunkte können zur Verbesserung der Gesamtnote verwendet werden, allerdings nur, wenn die Klausur bereits ohne diese Zusatzpunkte bestanden wurde.

Zu Beginn der Lehrveranstaltung werden die genauen Anforderungen und Modalitäten der Studienleistung bekannt gegeben, einschließlich der Art der Aufgabenstellung (zum Beispiel Einzel- oder Gruppenarbeit, Präsentationen oder Fallstudienanalyse). Es ist wichtig zu beachten, dass eine Bewertung von 1,0 auch ohne die zusätzlichen Punkte aus der Studienleistung erreicht werden kann.

Die Prüfung kann wahlweise in deutscher oder englischer Sprache absolviert werden.

Module ISHANDS-Health-M Digital Health *Digital Health*	6 ECTS / 180 h
Person responsible for module: Prof. Dr. Christian Maier	
Contents: Die Nutzung digitaler Technologien beeinflusst das Wohlbefinden von NutzerInnen auf unterschiedliche Arten. Es fördert die Gesundheit und das Wohlbefinden, indem digitale Technologien beispielsweise NutzerInnen dazu motivieren, regelmäßig aufzustehen oder Sport zu machen. Gleichzeitig geht die stetige Nutzung digitaler Technologien mit einem Stressempfinden einher, welches zu emotionaler Abgeschlagenheit oder Anzeichen von Burnout führen kann. Zusätzlich werden angrenzende Themen wie beispielsweise IT-Abhängigkeit oder Cybermobbing und verschiedene Trend-Themen wie beispielsweise Blockchain und KI mit Bezug zu Gesundheit thematisiert.	
Learning outcomes: Studierende lernen die Auswirkungen digitaler Technologie auf das Wohlbefinden kennen und können digitale Technologien dahingehend kritisch analysieren. Neben praxisnahen Erkenntnissen durch Fallstudien werden aktuelle Themenfelder der Wirtschaftsinformatik berücksichtigt.	
Remark: Alle Lehrmaterialien und Unterlagen für dieses Modul werden in englischer Sprache bereitgestellt. Die Vorlesungen sowie die Übungen werden jedoch in deutscher Sprache durchgeführt, um eine klare und verständliche Wissensvermittlung zu gewährleisten. Der Gesamtarbeitsaufwand für dieses Modul setzt sich wie folgt zusammen: • Aktive Teilnahme an Vorlesungen und Übungen: insgesamt etwa 45 Stunden. • Selbstständige Vor- und Nachbereitung der Vorlesungsinhalte sowie Übungen: ungefähr 90 Stunden. • Intensive Prüfungsvorbereitung: circa 45 Stunden. Zusätzlich besteht die Möglichkeit, eine freiwillige Studienleistung zu erbringen, für die maximal 10 Bonuspunkte vergeben werden. Die Teilnahme an der Studienleistung vertieft das Verständnis des Lehrstoffs und trägt zur Verbesserung der Gesamtbewertung des Moduls bei. Sowohl die Vorlesungen als auch die Übungen sind primär als Präsenzveranstaltungen konzipiert.	
prerequisites for the module: none	

Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Digital Health **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Christian Maier **Language:** German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: Die Vorlesung bietet einen Einblick in die verschiedenen Aspekte der Gesundheitsinformatik und deren transformative Rolle im Gesundheitswesen.	

Beginnend mit einer generellen Einführung beleuchtet die Vorlesung die Dualität digitaler Technologien. Dies beinhaltet beispielsweise Technologie-bedingten Stress, IT Abhängigkeit, Cybermobbing sowie positive Effekte von digitalen Technologien, nachdem diese von NutzerInnen in deren täglichen Routinen integriert werden. **Literature:** Jede Vorlesung baut auf aktueller, spezifischer Literatur auf, wie etwa: • Goh, J. M., Gao, G., & Agarwal, R. (2016). The Creation of Social Value: Can an Online Health Community Reduce Rural–Urban Health Disparities? MIS Quarterly, 40(1), 247–264. • Liang, H., & Xue, Y. (2022). Save face or save life: Physicians' dilemma in using clinical decision support systems. Information Systems Research 33(2), 737–758. • Maier, C., Laumer, S., Weinert, C. & Weitzel, T. (2015). The effects of technostress and switching-stress on discontinued use of social networking services: A study of Facebook use. Information Systems Journal, 25(3), 275–308. • Mattke, J., Maier, C., Hund, A. & Weitzel, T. (2019). How an Enterprise Blockchain Application in the U.S. Pharmaceutical Supply Chain is Saving Lives. MIS Quarterly Executive, 18(4), 246–261. • Meier, M., Maier, C., Thatcher, J. B., & Weitzel, T. (2023). Shocks and IS user behavior: A taxonomy and future research directions. Internet Research, 33(3), 853–889. • Park, E., Werder, K., Cao, L. & Ramesh, B. (2022). Why do Family Members Reject AI in Health Care? Competing Effects of Emotions. Journal of Management Information Systems, 39(3), 765–792. • Pfluegner, K., Maier, C., Thatcher, J. B., Mattke, J., & Weitzel, T. (2024). Deconstructing technostress: A configurational approach to explaining job burnout and job performance, MIS Quarterly	
2. Digital Health **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Health and Society in the Digital Age **Language:** German **Frequency:** every summer semester **Contents:** Die Übung vertieft die in der Vorlesung behandelten Theorien und Methoden der Gesundheitsinformatik. Mittels Fallstudien analysieren und diskutieren Studierende dabei die zuvor gelernten Theorien und Methoden. **Literature:** Siehe Vorlesung.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:**	

In der Klausur werden die Lerninhalte, die während der Vorlesungen und Übungen behandelt wurden, geprüft. Insgesamt können in der Klausur bis zu 90 Punkte erreicht werden. Studierende haben die Möglichkeit, durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen bis zu 10 zusätzliche Punkte zu erlangen. Diese Bonuspunkte können zur Verbesserung der Gesamtnote verwendet werden, allerdings nur, wenn die Klausur bereits ohne diese Zusatzpunkte bestanden wurde. Zu Beginn der Lehrveranstaltung werden die genauen Anforderungen und Modalitäten der Studienleistung bekannt gegeben, einschließlich der Art der Aufgabenstellung (zum Beispiel Einzel- oder Gruppenarbeit, Präsentationen oder Fallstudienanalyse). Es ist wichtig zu beachten, dass eine Bewertung von 1,0 auch ohne die zusätzlichen Punkte aus der Studienleistung erreicht werden kann. Die Prüfung kann wahlweise in deutscher oder englischer Sprache absolviert werden.	

Module ISM-DSI-M Global Collaboration and Digital Social Innovation *Global Collaboration and Digital Social Innovation*	6 ECTS / 180 h
(since WS23/24) Person responsible for module: Prof. Dr. Daniel Beimborn	
Contents: In 2015, the United Nations agreed on a common approach to peace and prosperity for people and the planet. At its core are the 17 Sustainable Development Goals (SDGs), which represent an urgent call to action by all countries as part of a global partnership. In particular, it is about developing strategies to improve health and education, reduce inequality, and boost economic growth – all while combating climate change and working to protect our oceans and forests. In this context, innovation on a global scale is an essential component. In particular, social innovation, defined as "a novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals" (Phills et al. 2008, p. 36), can have a positive impact not only on the economic conditions of individuals, but also on the environment (e.g., waste management) and politics (e.g., transparency in governance and political participation). Digital technologies can support these endeavors by allowing relevant stakeholders to interact across borders without hierarchical order or spatial restrictions. For instance, Ahuja and Chan (2020) show how entrepreneurs used a digital platform to orchestrate multiple to organize waste collection in India. Hence, digital social innovation aims at leveraging digital tools to address societal challenges. Objective of this project is to ideate, conceptualize and implement a digital solution to a social or environmental problem. To understand the wider implications of such sustainability problems and solutions, it is important to learn about other contexts, such as other countries with different business and legal regimes, or other cultures and mindsets. In this project, students will gain such a competence by collaborating in mixed teams with students from the Welingkar Institute of Management, Development and Research (WeSchool – a highly ranked business university with campuses in Mumbai and Bangalore). At the end of the semester, the German students will travel to India and finalize their project, present their results, and get also first-hand insights into the Indian culture and IT industry.	
Learning outcomes: After completing the course, students will understand the challenges, goals, and approaches of digital social innovation projects in different regions, such as in Germany and India. They will be able to design digital solutions to social problems, understand intercultural differences, and consider these when developing digital solutions. The course also prepares students to work in intercultural teams and promotes critical skills such as presenting work results and working on projects in a goal-oriented manner. During the visit to India, students will also get insights into the Indian culture, economy, and digital industry.	
prerequisites for the module: none	
Recommended prior knowledge: ISM-EidWI-B: Introduction into Information Systems ISM-FIISM-B: Fundamentals of International IS Management DSG-EiAPS-B: Introduction to Algorithms, Programming and Software	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units	
Global Collaboration and Digital Social Innovation **Language:** English/Deutsch / English on demand **Frequency:** every winter semester	**0,00 Weekly Contact Hours**

Learning outcome:

After completing the course, students will understand the challenges, goals, and approaches of digital social innovation projects in different regions, such as in Germany and India. They will be able to design digital solutions to social problems, understand intercultural differences, and consider these when developing digital solutions. The course also prepares students to work in intercultural teams and promotes critical skills such as presenting work results and working on projects in a goal-oriented manner. During the visit to India, students will also get insights into the Indian culture, economy, and digital industry.

Contents:

In 2015, the United Nations agreed on a common approach to peace and prosperity for people and the planet. At its core are the 17 Sustainable Development Goals (SDGs), which represent an urgent call to action by all countries as part of a global partnership. In particular, it is about developing strategies to improve health and education, reduce inequality, and boost economic growth – all while combating climate change and working to protect our oceans and forests. In this context, innovation on a global scale is an essential component. In particular, social innovation, defined as "a novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals" (Phills et al. 2008, p. 36), can have a positive impact not only on the economic conditions of individuals, but also on the environment (e.g., waste management) and politics (e.g., transparency in governance and political participation).

Digital technologies can support these endeavors by allowing relevant stakeholders to interact across borders without hierarchical order or spatial restrictions. For instance, Ahuja and Chan (2020) show how entrepreneurs used a digital platform to orchestrate multiple to organize waste collection in India. Hence, digital social innovation aims at leveraging digital tools to address societal challenges.

Objective of this project is to ideate, conceptualize and implement a digital solution to a social or environmental problem. To understand the wider implications of such sustainability problems and solutions, it is important to learn about other contexts, such as other countries with different business and legal regimes, or other cultures and mindsets. In this project, students will gain such a competence by collaborating in mixed teams with students from the Welingkar Institute of Management, Development and Research (WeSchool – a highly ranked business university with campuses in Mumbai and Bangalore).

At the end of the semester, the German students will travel to India and finalize their project, present their results, and get also first-hand insights into the Indian culture and IT industry.	

Examination Coursework Assignment with presentation, Global Collaboration and Digital Social Innovation	

Module ISM-IOM-M International Outsourcing Management *International Outsourcing Management*	6 ECTS / 180 h
(since WS20/21) Person responsible for module: Prof. Dr. Daniel Beimborn	

Contents:

- Grundlagen des Outsourcings: Definitionen, grundlegende Konzepte und Arten von Outsourcing; Geschichte, Trends; Märkte und Wachstum; Überblick über die wissenschaftliche Forschung im Outsourcing-Kontext
- Outsourcing-Gründe und grundlegende Theorien: Ökonomische und strategische Gründe für Outsourcing; Theorien zu Kosten- und strategischen Vorteilen, Kernkompetenzen usw.
- Outsourcing-Risiken: Ökonomische und strategische Risiken durch Outsourcing
- Outsourcing-Entscheidungen: Analyse der Nutzenpotenziale und Risiken durch Outsourcing; Modelle zur Bewertung der Vorteilhaftigkeit von Outsourcing; Prozess und Bewertungskriterien zur Auswahl von Dienstleistern
- Outsourcing-Verträge: Gestaltung und Verhandlung von Outsourcing-Verträgen und Service-Level-Agreements; Verhandlung mit einem Dienstleister; ausgewählte regulatorische Rahmenbedingungen
- Organisatorische Vorbereitungen im eigenen Unternehmen („Outsourcing Readiness"); Vorbereitung und Durchführung des Transitionsvorgangs
- Outsourcing-Governance: Aufbau einer Outsourcing-Governance zur Steuerung der Dienstleisterbeziehung; Kontrolle, Change-Management und Beziehungsmanagement; Management des Wissensaustausches und Fördern von Innovationen
- Besonderheiten beim Cloud Computing: Grundlegende Konzepte und Arten von Cloud Computing als besonderer Form von Outsourcing; Spezifische Vorteile, Herausforderungen und Risiken von Cloud Computing; spezifische Aspekte bei Cloud-basierten Sourcing-Entscheidungen sowie bei einer Cloud-Computing-Governance
- Offshore- und Nearshore-Outsourcing: Besonderheiten hinsichtlich Risiken, Kosten und Chancen; Bedeutung von und Umgang mit kulturellen Unterschieden; Globale IT-Delivery-Modelle
- Ökonomische und gesellschaftliche Auswirkungen von Outsourcing und Offshoring: Gesellschaftliche Reaktionen und Veränderungen; Implikationen für nationale Arbeitsmärkte und globale IT-Märkte

Learning outcomes:

Die Teilnehmer können Chancen und Risiken von IT-Outsourcing in Firmen identifizieren, Outsourcing-Projekte planen (Outsourcing-Strategie, Business Case, Auswahl unterschiedlicher Sourcing-Modi und Vendorenmodelle) und implementieren (Vertragsmanagement, Outsourcing-Governance, Beziehungsmanagement, Wissenstransfer). Damit sind Sie in der Lage,

- die grundlegenden Argumente für das Treffen von IT-Outsourcing-Entscheidungen zu identifizieren und zu evaluieren(Wann macht Outsourcing Sinn?),
- IT-Outsourcing-Optionen zu identifizieren und zu bewerten (Welche Form von Outsourcing ist sinnvoll?),
- IT-Outsourcing-Projekte zu planen und zu managen (Wie kann ein erfolgreicher Transfer zum Dienstleister gewährleistet werden?),
- eine Outsourcing-Governance zu implementieren (Wir wird gesteuert? Wer hat welche Verantwortlichkeiten inne?),
- IT-Outsourcing-Beziehungen zu gestalten und zu managen (Vertragsmanagement, Kontrolle, Beziehungsmanagement, Wissenstransfer) sowie

Nearshore- und Offshore-IT-Outsourcing-Optionen zu identifizieren und zu bewerten.

Remark:
Der Arbeitsaufwand für dieses Modul gliedert sich ungefähr wie folgt:

- Teilnahme an Vorlesung und Übung: insgesamt 45 Stunden
- Vor- und Nachbereitung der Vorlesung und Übung (inkl. Recherche und Studium zusätzlicher Quellen): 90 Stunden
- Prüfungsvorbereitung inkl. Prüfung: 45 Stunden (basierend auf dem bereits im obigen Sinne erarbeiteten Stoff)

Für das erfolgreiche Absolvieren des Moduls ist die regelmäßige Teilnahme an den Lehrveranstaltungen und die Vorbereitung von Fallstudien/Readings empfohlen.

prerequisites for the module:
none

Recommended prior knowledge:		**Admission requirements:**
none		none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

International Outsourcing Management — **4,00 Weekly Contact Hours**
Mode of Delivery:
Lecturers: Prof. Dr. Daniel Beimborn
Language: German
Frequency: every winter semester

Contents:
Outsourcing, der Fremdbezug von Leistungen von einem Dienstleister, ist eine wichtige Handlungsoption für IT-Manager. In diesem Modul werden Grundlagen, Vor- und Nachteile des Outsourcing sowie Entscheidungsmodelle, Vorgehensweisen, „Good Practices" („warum outsourcen, was outsourcen, wie outsourcen?"), aber auch Probleme und kulturelle Hürden im Bereich IT-Outsourcing und -Offshoring vermittelt, diskutiert und angewendet. Neben klassischem Outsourcing werden auch Cloud-basierte IT-Delivery-Modelle und die entsprechenden Management-besonderheiten betrachtet. Auf Basis von ausführlichen Vorlesungsunterlagen und mittels Diskussion von Fallstudien werden die Management-Anforderungen für die Gestaltung eines erfolgreichen Outsourcing-Arrangements umfassend vermittelt. Anhand von Übungsaufgaben werden die Inhalte zusätzlich ausführlich vertieft. Eine Vorbereitung der Lektüre für jede Einheit ist zwingend erforderlich. Die Universität Bamberg ist der einzige deutsche Academic Alliance Partner der International Association of Outsourcing Professionals (IAOP), die sich die globale Qualitätssteigerung und Standardisierung von Outsourcing-Management- Kompetenzen zum Ziel gesetzt hat. Entsprechend werden maßgeblich auch internationale (englischsprachige) Lehrmaterialien der IAOP verwendet.

Literature:
Beimborn, D. 2008. Cooperative Sourcing - Simulation Studies and Empirical Data on Outsourcing Coalitions in the Banking Industry. Wiesbaden: Gabler.

Carmel, E., and Tjia, P. 2005. Offshoring Information Technology - Sourcing and Outsourcing to a Global Workforce. Cambridge: Cambridge University Press.

IAOP. 2014. Outsourcing Professional Body of Knowledge. Zaltbommel: VanHaren Publishing.

Lacity, M.C., Khan, S.A., and Willcocks, L.P. 2009. "A Review of the IT Outsourcing Literature: Insights for Practice," Journal of Strategic Information Systems (18:3), pp 130-146.

Oshri, I., Kotlarksy, J., and Willcocks, L. 2015. The Handbook of Global Outsourcing and Offshoring. London, New York: Palgrave.

Weitere Literatur zu den einzelnen Themen wird in den jeweiligen Vorlesungen bekannt gegeben.

Examination
Written examination / Duration of Examination: 90 minutes
Description:
Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung und in der Modulprüfung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.

Module ISPL-DIGB-B Digital Business *Digital Business*	6 ECTS / 180 h

(since SS25)
Person responsible for module: Prof. Dr. Thomas Kude

Contents:
Digital business is omnipresent in today's world, fundamentally transforming how organizations operate and compete. This module provides a comprehensive introduction to the essential aspects of modern digital enterprises. Students will gain foundational knowledge on different logics of digital value creation and key concepts related to digital business, including digital business models, digital commerce, as well as digital products, services, and processes.

Students will explore technological and managerial aspects of digital business at various levels--industry, organizational, team, and individual. We discuss digital business from various perspectives, including but not limited to the underlying logic of digital value creation and associated technologies, different archetypical digital business models and organizational contexts, digital products, services, and processes. The course includes practical examples as well as methods and tools for creating and managing digital businesses.

Learning outcomes:
After having completing this module, participants will be able to:

- Understand the technological foundations and principles of digital business
- Design and manage digital products and services effectively
- Analyze digital business processes across organizational levels, industries, and domains
- Implement strategies for digital transformation in different business contexts

Remark:
The required workload of 180h is subdivided into:

- 56h for participation in lecture and exercise
- 124h for preparation and post-processing of sessions as well as exam preparation

prerequisites for the module:
none

Recommended prior knowledge: none Module Introduction into Information Systems (ISM-EidWI-B) - recommended	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Digital Business **Mode of Delivery:** **Lecturers:** Prof. Dr. Thomas Kude **Language:** English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**

Contents:

The course relies on various teaching methods, including lecture-style elements, in-class discussions, case examples, group work, and individual assignments. **Literature:** The specific literature that we will use in the course will be communicated or distributed in class or through the learning platform (VC).	

Examination Written examination / Duration of Examination: 90 minutes **Description:** The exam questions will incude the content from the lecture, exercises, and assignments. Students can reach 90 points in the exam. Students may obtain additional points to improve their grade through the voluntary participation in group or individual assignments. These points can be included in the exam points if a student would pass the exam without the additional points. The respective assignment, the available time, and the points that can be reached in each assignment will be communicated if and once such voluntary assignments are offered. The best grade (1,0) can be reached without participating in the voluntary assignments.	

Module ISPL-DPIS-M Digital Platforms in Industries and Society *Digital Platforms in Industries and Society*	6 ECTS / 180 h
(since SS25) Person responsible for module: Prof. Dr. Thomas Kude	
Contents: Digital platforms have become instrumental in shaping industries and societies, touching aspects from healthcare to artificial intelligence, and from personal well-being to urban development, to name just a few examples. This course delves into the multifaceted impact of digital platforms on industries and society, exploring both their potential benefits and the challenges they introduce. Beginning with an introduction to digital platforms and the platform economy, the course progresses to examine the implications of these platforms on individuals, collectives, and various industry sectors. Through a blend of theoretical discussions, practical case studies, and hands-on activities, students will gain a comprehensive understanding of the role digital platforms play in contemporary society.	
Learning outcomes: After the course, participants will be able to... • Understand the foundational concepts of digital platforms • Analyze the multi-faceted impacts of platforms on individuals and society • Examine the adaptation and transformation of various industries due to digital platforms • Engage critically with real-world impact of digital platforms from various perspectives • Develop strategies and opportunities to harness the potential of digital platforms in diverse sectors effectively	
Remark: The required workload of 180h is approximately subdivided into: • 56h for participation in lecture and exercise • 124h for preparation and post-processing of sessions as well as exam preparation	
prerequisites for the module: none	

Recommended prior knowledge: Good command of the English language.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Digital Platforms in Industries and Society **Mode of Delivery:** **Lecturers:** Prof. Dr. Thomas Kude **Language:** English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**
Contents: The course relies on various teaching methods, including lecture-style elements, in-class discussions, case examples, group work, and individual assignments.	
Literature:	

The specific literature that we will use in the course will be communicated or distributed in class or through the learning platform (VC).	

Examination Written examination / Duration of Examination: 90 minutes **Description:** The exam questions will include the content from the lecture, exercises, and assignments. Students can reach 90 points in the exam. Students may obtain additional points to improve their grade through the voluntary participation in group or individual assignments. These points can be included in the exam points if a student would pass the exam without the additional points. The respective assignments, the available time, and the points that can be reached in each assignment will be communicated if and once such voluntary assignments are offered. The best grade (1,0) can be reached without participating in the voluntary assignments.	

Module ISPL-FIISM-B Fundamentals of International IS Management *Fundamentals of International IS Management*	6 ECTS / 180 h

(since SS25)
Person responsible for module: Prof. Dr. Thomas Kude

Contents:
This module equips IISM students with the basics of their IISM curriculum and serves as an introductory course.

Building on the basics of information systems (IS)--such as the content of ISM-EidWI-B, SNA-WIM-B or similar courses--we develop a deeper understanding of IS management, international management, and idiosyncrasies of IS management in an international context. Accordingly, the course is structured along these three areas.

In this course, students will gain a deeper understanding of IS management tasks and issues with a particular focus on international contexts and environments. Therefore, the course will first give an overview about important IS management fields, then give an introduction to (general) international management, and finally combine both foundational parts by discussing particularities of managing information systems in an international context (i.e., the core of IISM). Accordingly, the course will consist of three parts:

Part 1: IS management

- IS strategy
- IS governance
- IS sourcing

Part 2: International management

- Theoretical and conceptual foundations of international management
- Organization of international firms
- Foreign market entry strategies
- Intercultural management and virtual teams

Part 3: International IS management

- Managing global IT organizations and people
- Managing global IT/software development projects and system roll-outs
- Managing offshore IT outsourcing
- Global issues of IS management--ethics and sustainability

Learning outcomes:
After having completed this course, students will have an understanding of IS management in an international context. They will be able to handle basic IS management tasks in an international environment and they will be sensitive to challenges caused by international and intercultural settings as well as by virtual collaboration.

Remark:
The workload of 180 academic hours is allocated as follows:

- 56h for participating in class
- 124h for preparation and post-processing of sessions as well as exam preparation

prerequisites for the module:

none

Recommended prior knowledge: ISM-EidWI-B (or any equivalent "Introduction to IS" course) is required. SNA-WIM-B is recommended, but not necessary (students can catch up the relevant parts by reading some extra literature).		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:** from 4.	**Minimal Duration of the Module:** 1 Semester

Module Units	
Fundamentals of International IS Management **Mode of Delivery:** **Lecturers:** Prof. Dr. Thomas Kude **Language:** English **Frequency:** every summer semester	**4,00 Weekly Contact Hours**
Contents: The course relies on various teaching methods, including lecture-style elements, in-class discussions, case examples, group work, and individual assignments.	
Literature: Will be announced in class.	

Examination Written examination / Duration of Examination: 90 minutes **Description:** In the exam, the content covered in the module (lecture, exercise, readings) is examined. The maximum number of points in the exam is 90. It is possible to earn bonus points for the exam during the lecture term. Earned bonus points will be credited to the results if the exam has been passed successfully. Bonus points can be earned by completing a voluntary, written coursework in which students have to work independently on transfer tasks related to the lecture course. It will be announced at the beginning of the course whether bonus points are offered. If bonus points are offered, the number, type, scope, and duration of the assignments as well as the number of attainable bonus points will be announced at this time. A final grade of 1.0 can be achieved without bonus points from the coursework.	

Module ISPL-MASI-B Supplier relationships and mergers & acquisitions in the software industry *Supplier relationships and mergers & acquisitions in the software industry*	3 ECTS / 90 h
(since WS24/25) Person responsible for module: Prof. Dr. Thomas Kude further responsible : Popp, Michael, Karl Dr.	
Contents: This course equips students with the basics of key activities in the software industry: software supply chains and mergers & acquisitions. The content ranges from supply side value chains, like inbound OEM, open-source components or APIs, to mergers and acquisitions, including players, deal types, processes, opportunities, and risks, with a detailed examination of goals, valuations, and transactions in the recent software M&A market.	
Learning outcomes: After successful completion of this course, participants will be able to: 1. Analyze supply chains of software vendors. 2. Define and evaluate supply relationships in software supply chains by discussing risks and opportunities of such relationships. 3. Identify players and roles in mergers and acquisitions processes. 4. Define phases and tasks of M&A processes. 5. Understand and discuss valuations of software companies. 6. Analyze opportunities and risks of M&A projects.	
prerequisites for the module: none	
Recommended prior knowledge: none	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Supplier relationships and mergers & acquisitions in the software industry **Mode of Delivery:** Lectures and Practicals **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: This course equips students with the basics of key activities in the software industry: software supply chains and mergers & acquisitions. The content ranges from supply side value chains, like inbound OEM, open-source components or APIs, to mergers and acquisitions, including players, deal types, processes, opportunities, and risks, with a detailed examination of goals, valuations, and transactions in the recent software M&A market.	
Literature:	

Will be announced in class.	

Examination Written examination / Duration of Examination: 90 minutes **Description:** The exam questions will incude the content from the lecture, exercises, and assignments.	

Module ISPL-MDP-M Managing Digital Platforms *Managing Digital Platforms*	6 ECTS / 180 h
(since SS25) Person responsible for module: Prof. Dr. Thomas Kude	

Contents:

PLEASE NOTE: This module will not be offered in the summer semester 2025 due to Prof. Kude´s research semester. The exam will take place.

Digital platforms are ubiquitous in industries and in society and both researchers and practitioners have recognized their disruptive potential. Large technology companies, such as Apple, Alibaba, Amazon, or SAP, rely on a platform business model and the emergence of the thriving platform economy has contributed to the meteoric rise of some platform owners to top the lists of the most valuable companies in the world. The central actors in the context of digital platforms include the platform owner that provides the platform itself along with interfaces and other resources, outside third-party actors that provide complementary products and services, as well as the users of the platform. For example, in the context of mobile app ecosystems, complementors can leverage platform functionality of iOS or Android to create apps and use Apple’s App Store or the Google Play Store to offer them to iPhone or Android users.

In this course, we develop a comprehensive understanding of the management of digital platforms through an in-depth exploration of the roles and mechanisms of digital platforms and the surrounding ecosystems. After laying the foundations of digital platform management, we will dive into advanced questions of platform design and management, e.g., related to platform launch, to governing third-party contributions, or to key success factors for the various actors in digital platform ecosystems. The course relies on both theoretical insights and practical cases across industries and companies.

We will work on central topics of managing platform ecosystems, including, but not limited to:

- Foundations of digital platforms
- Launching and monetizing digital platforms
- Digital platform governance
- The role of complementors in digital platforms

Learning outcomes:

After the course, participants will be able to...

- Recognize the growing importance of digital platforms
- Analyze the underlying mechanisms and the roles of different actors in digital platform ecosystems
- Make decisions regarding the governance of different types of platforms
- Develop strategies and business models for complementor organizations that benefit from and depend on digital platforms

Remark:

The required workload of 180h is approximately subdivided into:

- 56h for participation in lecture and exercise
- 124h for preparation and post-processing of sessions as well as exam preparation

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
Good command of the English language	none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Managing Digital Platforms **Mode of Delivery:** **Lecturers:** Prof. Dr. Thomas Kude **Language:** English **Frequency:** every summer semester **Literature:** The specific literature that we will use in the course will be communicated or distributed in class or through the learning platform (VC).	**4,00 Weekly Contact Hours**

Examination
Written examination / Duration of Examination: 90 minutes **Description:** The exam questions will include the content from lecture, exercises, and assignments. Students can reach 90 points in the exam. Students may obtain additional points to improve their grade though the voluntary participation in group or individual assignments These points can be included in the exam points if a student would pass the exam without the additional points. The respective assignments, the available time, and the points that can be reached in each assignment will be communicated if and once such voluntary assignments are offered. The best grade (1,0) can be reached without participating in the voluntary assignments.

Module Inf-DM-B Discrete Modelling *Diskrete Modellierung*	9 ECTS / 270 h
(since WS24/25) Person responsible for module: Prof. Dr. Isolde Adler	
Contents: Modellieren ist eine grundlegende Arbeitstechnik in vielen Bereichen der Informatik und darüber hinaus. Modelle dienen der exakten Beschreibung von Szenarien und sind damit die Voraussetzung zum Lösen von Problemen mittels Methoden der Informatik. Dabei ist es wichtig, die Modelle passend zur Problemstellung zu wählen. Hier bietet die diskrete Mathematik ein vielfältiges Handwerkszeug. Für das nachhaltige, verlässliche Modellieren sowie für das Lösen von Problemen ist es wichtig, das exakte Argumentieren zu erlernen. Deshalb ist das Einüben der Sprache der Mathematik ein zentrales Thema in diesem Modul. Sie bietet die Sicherheit, sich auf die Modelle und Lösungen verlassen zu können. In diesem Modul werden Aussagen- und Prädikatenlogik, Mengen, Relationen und Funktionen, Graphen, Bäume, und Methoden der Kombinatorik, formale Sprachen und endliche Automaten eingeführt und anhand von Modellierungsbeispielen besprochen. Zudem werden mathematische Beweistechniken eingeführt und eingeübt.	
Learning outcomes: Vertrautheit mit unterschiedlichen Modellierungsmethoden Sicherheit im mathematisch exakten Argumentieren Vertrautheit mit grundlegenden Definitionen und Eigenschaften aus dem Bereich der diskreten Mathematik und mit deren Rolle in der Informatik Sicherheit in der Entwicklung von Strategien zur Problemlösung Analytische Fähigkeiten	
prerequisites for the module: Keine	
Recommended prior knowledge: Interesse an formalen Methoden. Dies ist eine grundlegende Veranstaltung, die für die ersten Studiensemester empfohlen wird.	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Diskrete Modellierung **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Isolde Adler **Language:** English **Frequency:** every winter semester	**6,00 Weekly Contact Hours**
Contents:	

In der Vorlesung werden die Themen motiviert und eingeführt, im Detail erklärt sowie Techniken und Methoden vorgestellt. Es werden Beispiele, Beweise, typische Fragestellungen und Anwendungen in der Informatik besprochen.	

Examination Written examination **Description:** Examination: written exam (e-exam), duration: 120 minutes. Schriftliche Prüfung (E-Prüfung), Prüfungsdauer: 120 Minuten.	

Module Inf-Proj-M Master‘s Project in Computer Science *Masterprojekt der Fachgruppe Informatik*	6 ECTS / 180 h
(since WS25/26) Person responsible for module: Prof. Ph.D. Michael Mendler further responsible : (qua office the degree programme representative for the International Software Systems Science master’s degree)	
Contents: This module covers the application of foundational methods in the area of Computer Science in the context of a practical project. The available topics are determined by the teaching and research unit that is offering the project.	
Learning outcomes: Building on the knowledge and skills obtained from the lectures and seminars of the graduate degree studies, the project tackles a scientific research question or an advanced software development problem that will typically be related to the current scientific research of the offering teaching unit. Depending on the project’s objectives, the work may be pursued as an individual project or a group project. The project provides competencies for conducting independent academic research; problem solving skills exploiting the current state of the art in science and technology, competencies for goal-oriented self-organisation, time management and team work; competencies written and oral presentations following academic standards.	
Remark: The master’s project is chosen from among the offerings in one of the areas of Computer Science. The available projects can be identified in UnivIS with the key phrase "Inf-Proj" and must be explicitly specified as suitable for master’s students.	
prerequisites for the module: none	
Recommended prior knowledge: The recommended specific study prerequisites are determined and communicated by the teaching unit offering the module. Typically, there may be thematically pertinent modules from the respective teaching unit that should have been successfully attended before.	**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Masterprojekt der Fachgruppe Informatik **Mode of Delivery:** **Language:** English/German **Frequency:** every semester	**4,00 Weekly Contact Hours**
Learning outcome: As described for the module.	
Contents: The contents of the master’s projects will be determined and communicated by the teaching unit offering the module.	

Literature: The reading list will be announced at the beginning of the project and communicated by the teaching unit offering the module.	

Examination Coursework Assignment and Colloquium **prerequisites for module examination:** Regular participation in teaching classes **Description:** The assessment is based on a written homework and a colloquium. The work duration and deadline for the written deliverable as well as the duration of the colloquium will be determined by the supervisor of the project, at the beginning of the semester.	

Module Inf-Projekt1-B Bachelor Project 1 in Computer Science *Bachelorprojekt 1 der Fächergruppe Informatik*	6 ECTS / 180 h

(since WS25/26)
Person responsible for module: Prof. Dr. Daniela Nicklas
further responsible : (qua Amt der bzw. die Studiengangsbeauftragte für den Bachelorstudiengang Informatik)

Contents:
Das Modul behandelt die praktische Anwendung grundlegender Methoden aus dem Bereich der Informatik im Rahmen eines Projektes. Die behandelten Problemstellungen stammen aus den typischen Fachgebieten der Informatik.

Learning outcomes:
I.d.R aufbauend auf den in den Vorlesungen und Übungen des jeweiligen Faches erworbenen Kenntnissen und Fertigkeiten wird im Projekt eine Forschungs- und/oder Entwicklungsaufgabe mit wissenschaftlichem Bezug in einer Gruppe bearbeitet. Dabei werden die Fähigkeiten im

Bereich der Systemanalyse und -entwicklung ebenso weiterentwickelt wie die Kompetenzen in der Projektdurchführung und in der Gruppenarbeit.

Remark:
Es ist ein Bachelorprojekt aus einem der Fachgebiete der Informatik zu wählen.

Die wählbaren Projekte sind in UnivIS über das Schlagwort "Inf-Projekt" auffindbar und als Projekte für Bachelorstudierende ausgewiesen.

prerequisites for the module:
keine

Recommended prior knowledge: Empfohlene Vorkenntnisse werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben. In der Regel sollten zuvor bereits andere Module aus dem Fachgebiet belegt worden sein.	**Admission requirements:** none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units

Bachelorprojekt 1 der Fächergruppe Informatik **Mode of Delivery:** **Language:** German/English **Frequency:** every semester	**4,00 Weekly Contact Hours**

Learning outcome:
wie beim Modul beschrieben

Contents:
Die Inhalte der Bachelorprojekte werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben.

Literature:

Die Literatur wird zu Beginn eines Projekts von jedem anbietenden Fachgebiet bekannt gegeben.	

Examination Coursework Assignment and Colloquium **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Als Prüfungsleistung ist eine Hausarbeit sowie ein Kolloquium zu erbringen. Die Bearbeitungsfrist der Hausarbeit und die Prüfungsdauer des Kolloquiums werden von der Betreuerin bzw. dem Betreuer des Projekts zu Beginn der Lehrveranstaltung bekannt gegeben.	

Module Inf-Sem-M Master's Seminar in Computer Science *Masterseminar in Informatik*	3 ECTS / 90 h

(since SS25)
Person responsible for module: Prof. Ph.D. Michael Mendler
further responsible : (qua office the degree programme representative for the International Software Systems Science master’s degree)

Contents:
Independent academic research of a specific topic in the area of Computer Science and the structuring, analysis and presentation of the findings using scientific methods.

Learning outcomes:
Competencies for the systematic identification, critical and systematic analysis of the scientific literature pertinent to a given specific topic in the field of Computer Science; competencies for structuring of complex research issues in a delimited area with a critical assessment of the available competing approaches in the state of the art; advanced skills to communicate scientific results efficiently while applying academic standards; basic skills to generate own scientific texts; competencies to review as well as assess existing published academic work; further development of the student’s scientific curiosity supported by a self-confident, research-oriented attitude towards computer science.

Remark:
The master’s seminar is chosen from among the offerings in one of areas of Computer Science. The available seminars can be identified in UnivIS with the key phrase "Inf-Sem" and must be explicitly specified as suitable for master’s students.

prerequisites for the module:
none

Recommended prior knowledge: The recommended specific study prerequisites are determined and communicated by the teaching unit offering the module. Typically, there may be thematically pertinent modules from the respective teaching unit that should have been successfully attended before.	**Admission requirements:** none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Masterseminar in Informatik **Mode of Delivery:** Seminar **Language:** English/German **Frequency:** every semester	**2,00 Weekly Contact Hours**

Learning outcome:
As described for the module.

Contents:
The contents of the master’s projects will be determined and communicated by the teaching unit offering the module.

Literature:

The reading list will be announced at the beginning of the project and communicated by the teaching unit offering the module.	

Examination Coursework Assignment with presentation **prerequisites for module examination:** Regular participation in teaching classes **Description:** The assessment is based on a written homework and presentation. Alternatively, the assessment can be based on a written homework and a colloquium. The work duration and deadline for the written deliverable as well as the duration of the presentation or colloquium will be determined by the lecturer of the seminar, at the beginning of the semester.	

Module Inf-Seminar1-B Bachelor Seminar 1 in Computer Science *Bachelorseminar 1 der Fächergruppe Informatik*	3 ECTS / 90 h
(since SS25) Person responsible for module: Prof. Dr. Daniela Nicklas further responsible : (qua Amt der bzw. die Studiengangsbeauftragte für den Bachelorstudiengang Informatik)	
Contents: Eigenständige Erarbeitung und Präsentation eines Themas aus dem gewählten Fachgebiet der Informatik mit wissenschaftlichen Methoden.	
Learning outcomes: Kompetenzerwerb in den Bereichen kritische und systematische Literaturanalyse, Strukturierung komplexer Sachverhalte, bewertender Vergleich konkurrierender Ansätze. Professionelle Präsentation von Fachthemen. Erlernen des Verfassens wissenschaftlicher Arbeiten.	
prerequisites for the module: keine	
Recommended prior knowledge: Empfohlene Vorkenntnisse werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben. In der Regel sollten zuvor bereits andere Module aus dem Fachgebiet belegt worden sein	**Admission requirements:** none

Frequency: every semester	**Recommended semester:** from 4.	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelorseminar 1 der Fächergruppe Informatik **Mode of Delivery:** Seminar **Language:** German/English **Frequency:** every semester	**2,00 Weekly Contact Hours**
Learning outcome: wie beim Modul beschrieben	
Contents: Die Inhalte der Bachelorseminare werden von jedem anbietenden Fachgebiet festgelegt und bekannt gegeben.	
Literature: Die Literatur wird zu Beginn eines Seminars von jedem anbietenden Fachgebiet bekannt gegeben	

Examination Coursework Assignment with presentation **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Als Prüfungsleistung ist eine Hausarbeit sowie ein Referat zu erbringen.	

Alternativ kann die Prüfungsleistung auf Hausarbeit mit Kolloquium festgelegt werden. Die Bearbeitungsfrist der Hausarbeit und die Prüfungsdauer des Referats bzw. des Kolloquiums werden zu Beginn einer jeden Lehrveranstaltung von der Seminarleiterin bzw. dem Seminarleiter bekannt gegeben.	

Module KogSys-KI-B Introduction to Artificial Intelligence *Einführung in die Künstliche Intelligenz*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Ute Schmid	
Contents: The module provides an introduction to the basic concepts and methods of Artificial Intelligence. Central topics are search and problem solving, games and constraints, knowledge representation and logic, reasoning, and planning. Selected aspects of advanced topics from the areas of uncertain knowledge, machine learning, language and communication, image analysis and robotics are covered. In addition to the theoretical basics, the implementation of AI algorithms in Scheme and Prolog is taught. The lecture also addresses the history of AI, interdisciplinary references, in particular to philosophy and psychology, as well as ethical questions of AI. List of topics: • Problem solving and search • Search algorithms for games • Approaches to knowledge representation • Propositional and first order logic • Inference in first order logic • Non-classical logics • Planning • Machine Learning • Language Processing • Object and scene recognition	
Learning outcomes: • Be able to define and explain basic concepts and problems of AI • Be able to apply simple AI algorithms to specific – including new – problems • Be able to model problems formally, in particular using logic • Master the basics of AI programming techniques (especially functional and logical programming)	
Remark: • Be able to define and explain basic concepts and problems of AI • Be able to apply simple AI algorithms to specific – including new – problems • Be able to model problems formally, in particular using logic • Master the basics of AI programming techniques (especially functional and logical programming)	
prerequisites for the module: (except for interdisciplinary module Cognitive Artificial Intelligence) • GdI-MfI-1 (Propositional and Predicate Logic) • DSG-EiAPS-B (Introduction to Algorithms, Programming and Software)	
Recommended prior knowledge: Knowledge in the following areas, associated modules in brackets: • Algorithms and Data Structures (AI-AuD-B)	**Admission requirements:** None

• Introduction to Functional Programming (GdI-IFP-B) • Fundamentals of Theoretical Informatics (GdI-GTI-B) • Linear Algebra (xAI-MML-M, KTR-MfI-2-B)		
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Introduction to Artificial Intelligence **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Ute Schmid **Language:** German/English **Frequency:** every summer semester **Learning outcome:** see module description **Contents:** Presentation and discussion of the contents (see module description), in particular theoretical and conceptual aspects. **Literature:** Stuart Russel and Peter Norvig (2010, 3rd edition). Artificial Intelligence, a modern approach. Prentice Hall	**2,00 Weekly Contact Hours**
Examination / Duration of Examination: 105 minutes **Description:** The duration of the exam includes a reading time of 15 minutes in order to be able to select the tasks to be completed within the scope of the options available. 90 points can be achieved in the written examination. The exam is passed if at least 40 percent are achieved. Voluntary assignments are issued during the semester. By voluntarily completing the assignments, students can collect points to improve their grade, which can be credited towards the exam, provided that the exam is passed even without points from the optional assignments. This will be announced at the beginning of the course: • Type and number of assignments • Scope (number of achievable points) of the assignments • Duration for completing the assignments A grade of 1.0 can also be achieved without points from the assignments. Permitted aids: Handwritten and printed materials, calculator without full alphanumeric keyboard and graphic display. The tasks in the exam are provided in German and English.	

Module Units	
Introduction to Artificial Intelligence **Mode of Delivery:** Practicals **Lecturers:** Bettina Finzel **Language:** German/English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Learning outcome: see module description	
Contents: Practical consolidation of the contents of the lecture: • Repetition and consolidation of theoretical concepts presented in the lecture • Simulation of algorithms for search, logical inference, planning and machine learning (manual and programmatic) • Tasks for knowledge modeling and for modeling logical worlds • Calculation of heuristics • Probability calculation • Elaboration of example applications in which artificial intelligence can be used • Presentation and discussion of task solutions	

Module MOBI-ADM-M Advanced Data Management *Advanced Data Management*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since SS21) Person responsible for module: Prof. Dr. Daniela Nicklas	
Contents: With the rapid growth of the internet and more and more observable processes, many data sets became so large that they cannot be processed with traditional database methods any more. This modul covers advanced data management and integration techniques (also known under the term “big data”) that are useful when dealing with very large data sets.	
Learning outcomes: The students will understand the challenges of big data, and will be able to apply some of the new techniques to deal with it.	
Remark: The main language of instruction in this course is English. However, the lectures and/or tutorials may be delivered in German if all participating students are fluent in German. The written reports/seminar essay and the presentation may be delivered in English or in German.	
prerequisites for the module: none	

Recommended prior knowledge: Foundations of relational databases, relational algebra and SQL; e.g. from Modul SEDA-DMS-B: Data management systems		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Lectures Advanced Data Management **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Daniela Nicklas **Language:** English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: The lecture will cover various algorithms for clustering, association rule mining, or page ranking and their scalable processing using map and reduce methods, data integration, data cleansing and entity recognition. The exercises will be built upon the Hadoop framework. The language of the course will be announced in the first lecture.	
Literature: L. Wiese, Advanced Data Management, For SQL, NoSQL, Cloud and Distributed Databases. Berlin, Boston: De Gruyter, 2015	
2. Practicals Advanced Data Management **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Daniela Nicklas	**2,00 Weekly Contact Hours**

Language: English
Frequency: every summer semester

Contents:
see Lectures

The language of the course will be announced in the first lecture.

Examination
Written examination / Duration of Examination: 75 minutes
Description:
Central written exam. The examination language is English.

The exam questions will be in English. The questions can be answered in English or German. The content that is relevant for the exam consists of the content presented in the lecture and in the practical assignments.

The exam consists of 7 tasks of which only 6 will be graded. The exam time includes a reading time of 15 minutes to select the tasks to be completed within the scope of the choices.

Participants who submit solutions for practical assignments can achieve bonus points. Details regarding the number of assignments, the number of bonus points per assignment, the conversion factor from bonus points to exam points (e.g., 10:1) and the type of assignments will be announced in the first practical assignment session.

If the points achieved in the exam are sufficient to pass the exam on its own (generally, this is the case when at least 50% of the points have been obtained), the converted bonus points will be added to the points achieved in the exam.

The grade 1.0 can be achieved without the bonus points.

Module MOBI-DSC-M Data Streams and Complex Event Processing *Data Streams and Complex Event Processing*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium
(since WS25/26) Person responsible for module: Prof. Dr. Daniela Nicklas	
Contents: The management of data streams and foundations of event processing: Applications, systems, query languages, continuous query processing, and security in distributed data stream management systems. The modul covers the following topics: Architectures of data stream management systems; Query languages; Data stream processing; Complex event processing; Security in data stream management systems; Application of data stream management systems	
Learning outcomes: Understand the challenges of data stream management and complex event processing Recognize and link basic building blocks of data stream management tasks in different frameworks and systems Develop and program queries on data streams and event streams in different query languages to process data streams and detect event patterns Understand basic implementation techniques for data stream operators Understand the main security challenges and solutions in data stream management systems	
prerequisites for the module: none	
Recommended prior knowledge: Foundations of relational databases, relational algebra and SQL; e.g. from Modul MOBI-DBS-B: Database Systems	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Data Streams and Complex Event Processing **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Daniela Nicklas **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Learning outcome: Understand the challenges of data stream management and complex event processing Recognize and link basic building blocks of data stream management tasks in different frameworks and systems Develop and program queries on data streams and event streams in different query languages to process data streams and detect event patterns Understand basic implementation techniques for data stream operators	

Understand the main security challenges and solutions in data stream management systems **Contents:** The management of data streams and foundations of event processing: Applications, systems, query languages, continuous query processing, and security in distributed data stream management systems. The modul covers the following topics: Architectures of data stream management systems; Query languages; Data stream processing; Complex event processing; Security in data stream management systems; Application of data stream management systems	
Examination Oral examination / Duration of Examination: 15 minutes **Description:** oral or written exam (will be announced in class at the beginning of the semester). The examination language is English.	

Module Units	
Data Streams and Complex Event Processing **Mode of Delivery:** Practicals **Language:** English **Frequency:** every winter semester **Contents:** see lecture	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 60 minutes **Description:** oral or written exam (will be announced in class at the beginning of the semester). The examination language is English.	

Module NLProc-ALV-B Natural Language Understanding *Algorithmisches Sprachverstehen*	6 ECTS / 180 h
(since SS24) Person responsible for module: Prof. Dr. Roman Klinger	
Contents: The lecture on natural language processing covers a set of topics: • Overview Natural Language Understanding • Lexical Semantics • Distributional Semantics • Word Embeddings • Contextualized Representations • Information Extraction • Semantic Role Labeling • Argument Mining • Sentiment Analysis • Natural Language Inference and Language Models for Instruction Answering	
Learning outcomes: The student understands challenges and tasks in natural language understanding and acquired a basic knowledge of methods to approach and solve them.	
prerequisites for the module: none	
Recommended prior knowledge: The lecture on natural language understanding loosely builds on top of the Information Retrieval and Text Mining (IRTM) lecture. In the IRTM lecture, we learned how to handle text documents, search in them, classify them, and group them. We also looked into machine learning methods that help us organizing them. In natural language understanding, we look deeper into text and study the content on the word, phrase, sentence or paragraph level. However, it will also be possible to follow this lecture without having attended IRTM. Prior knowledge in programming is, however, required.	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:** from 4.	**Minimal Duration of the Module:** 1 Semester

Module Units	
Einführung in das Algorithmische Sprachverstehen **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Roman Klinger **Language:** Deutsch / English on demand/German **Frequency:** every winter semester	**4,00 Weekly Contact Hours**
Contents: The lecture on natural language processing covers a set of topics: • Overview Natural Language Understanding	

• Lexical Semantics • Distributional Semantics • Word Embeddings • Contextualized Representations • Information Extraction • Semantic Role Labeling • Argument Mining • Sentiment Analysis • Natural Language Inference and Language Models for Instruction Answering	
Literature: Daniel Jurafsky and James Martin, Speech and Language Processing, An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition	
Examination Written examination / Duration of Examination: 60 minutes	

Module NLProc-ANLP-M Applied Natural Language Processing *Angewandte maschinelle Sprachverarbeitung*		6 ECTS / 180 h
(since WS24/25 to SS25) Person responsible for module: Prof. Dr. Roman Klinger		
Contents: The module of Applied Natural Language Processing can be filled with various specialized courses from the Chair of Fundamentals of Natural Language Processing. This includes specialized lectures and seminars. The module is worth 6 credit points. Therefore two classes of 3 credit points can be combined or one 6 credit point class can be taken.		
Learning outcomes: The student learns about recent research topics in natural language processing, learns to familiarize themselves with state of the art methods and challenges, and learns to build on knowledge from machine learning, deep learning, structured learning, computational linguistics, and semantics.		
prerequisites for the module: none		
Recommended prior knowledge: • Information Retrieval and Text Mining (recommended) • Algorithmisches Sprachverstehen (recommended) • Deep Learning (very helpful)		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Explainable AI Methods and Applications in Natural Language Processing **Mode of Delivery:** Seminar **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Learning outcome: The course aims to examine current research directions on various topics of explainablility in NLP. In particular, we will focus on explaining the inner workings of neural-networks and other models traditionally considered to be "black boxes." Participants will read and discuss research papers, learning to critically question the results presented within, identify gaps in knowledge and develop ideas for further research.	
Contents: Topics include · Bias and bias detection · Model attribution analysis · Interpretability of word embeddings · Attention-based explainability · Adversarial attacks and counterfactuals	

· Model Debugging and Error Analysis **Literature:** Zhang, Edwin, et al. "Transcendence: Generative Models Can Outperform The Experts That Train Them." *arXiv preprint arXiv:2406.11741* (2024). Li, Jiaoda, Yifan Hou, and Mrinmaya Sachan Ryan Cotterell. "What Do Language Models Learn in Context? The Structured Task Hypothesis." *arXiv e-prints* (2024): arXiv-2406. Goldfarb-Tarrant, Seraphina, et al. "Bias beyond English: Counterfactual tests for bias in sentiment analysis in four languages." *arXiv preprint arXiv:2305.11673* (2023). Marco Ribeiro, Sameer Singh, and Carlos Guestrin. 2016. “Why Should I Trust You?”: Explaining the Predictions of Any Classifier. In Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Demonstrations, pages 97–101, San Diego, California. Association for Computational Linguistics.	
2. Multi-Modal Language Technology **Mode of Delivery:** Seminar **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
3. Argument Mining **Mode of Delivery:** Seminar **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
4. Large Language Models for Natural Language Understanding **Mode of Delivery:** Seminar **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
5. Emotion Analysis **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Roman Klinger **Language:** English **Frequency:** every summer semester **Learning outcome:** This class discusses the fundaments of emotion theories in psychology and how they can be used for computational modeling, such that computers can interpret emotions in text. The content is: • Emotion theories • Appraisal theories • Lexicons and applications of emotion analysis • Machine and deep learning for emotion analysis • Event interpretation • Structured analyses of emotions	**2,00 Weekly Contact Hours** **3.0 ECTS**

6. Emotion Analysis Project **Mode of Delivery:** **Lecturers:** Prof. Dr. Roman Klinger **Language:** English/German **Frequency:** every semester **Learning outcome:** The student learns to apply emotion analysis methods to new tasks and domains. **Contents:** This course extends the Emotion Analysis lecture of 3 credit points to a course of 6 credit points can only be taken together with the lecture. This is not a standard "project" course but an extension of the emotion analysis lecture which can not be taken without the lecture.	**2,00 Weekly Contact Hours** **3.0 ECTS**
Examination Internship report **Description:** This module can be filled with either a specialized lecture (3 ECTS) together with a short additional project (another 3 ECTS) or with a seminar; or two seminars (each 3 ECTS). Depending on the class type, the exam will take on a different modality. Typically, for seminars it is a presentation and a written paper ("Referat + Hausarbeit") while for the emotion analysis course it is Hausarbeit + Colloquium. Other future classes might decide on a different modality. Students will be informed in the first week of a lecture about that.	

Module NLProc-EA-M Emotion Analysis *Emotion Analysis*	6 ECTS / 180 h
(since WS25/26) Person responsible for module: Prof. Dr. Roman Klinger	
Contents: This class discusses the fundaments of emotion theories in psychology and how they can be used for computational modeling, such that computers can interpret emotions in text. We discuss psychological emotion theories, including appraisal theories, which explain how events are evaluated regarding their emotional connotation. We discuss how lexical resources can be created that contain emotion words and their common emotion interpretation. We look into machine learning methods to estimate models for emotion analysis and structured analysis, including role labeling. The course is taught as a 2 SWS lecture with assignments that the students present, accompanied by a practical project that students work on independently under supervision.	
Learning outcomes: The students obtained a good understanding of the psychological background on emotions as it is required to develop emotion analysis systems. Based on the use case of emotion analysis, they obtained a deeper insight in how natural language processing systems are created, including resource creation, model training, evaluation, and interpretation.	
prerequisites for the module: none	
Recommended prior knowledge: Having attended at least one of the following courses (ideally all of them, as the emotion analysis course describes a concrete application of the methods taught in these lectures): Information Extraction and Text Mining Natural Language Processing Deep Learning for Natural Language Processing	**Admission requirements:** none

Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Emotion Analysis **Language:** German **Frequency:** every winter semester	**0,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium	

Module NLProc-ILT-M Impact of Language Technology *Impact of Language Technology*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Roman Klinger	
Contents: Topics include • Value Sensitive Design, • Bias and Discrimination, • Intersectionality, • Emergent Bias in Translation Technologies, • Content Moderation and Toxicity Detection, • Documentation and Transparency, • Science Communictation, • Privacy	
Learning outcomes: This course aims to deepen our understanding of the ethical issues associated with deploying NLP technology. We will explore how to identify those likely to be affected by the technology (both direct and indirect stakeholders), assess the risks involved, and design systems that better align with stakeholder values. Through discussions of readings from the expanding body of research on fairness, accountability, transparency, and ethics in NLP and related fields, as well as value-sensitive design, we will address the following questions: - What specific harms can arise from the use of NLP systems? - How can we fix, prevent, or mitigate these harms? - What responsibilities do we have as NLP researchers and developers in this context?	
prerequisites for the module: none	

Recommended prior knowledge: Required is an understanding of machine learning techniques and mechanisms, knowledge of NLP is a plus but not required		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Societal Impact of Language Technology **Mode of Delivery:** Lectures and Practicals **Language:** English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**
Learning outcome: This course aims to deepen our understanding of the ethical issues associated with deploying NLP technology. We will explore how to identify those likely to be affected by the technology (both direct and indirect stakeholders), assess the risks involved, and design systems that better align with stakeholder values.	

Through discussions of readings from the expanding body of research on fairness, accountability, transparency, and ethics in NLP and related fields, as well as value-sensitive design, we will address the following questions:
- What specific harms can arise from the use of NLP systems?
- How can we fix, prevent, or mitigate these harms?
- What responsibilities do we have as NLP researchers and developers in this context?

Contents:
Topics include

- Value Sensitive Design,
- Bias and Discrimination,
- Intersectionality,
- Emergent Bias in Translation Technologies,
- Content Moderation and Toxicity Detection,
- Documentation and Transparency,
- Science Communictation,
- Privacy

Literature:
A variety of different sources from current research are used. Among them:
Birhane, A. 2021. The Impossibility of Automating Ambiguity. Artificial Life, 27(1):44-61.
Lewis, J.E. et al, 2020. Indigenous Protocol and Artificial Intelligence

Friedman, B. (1996). Value-sensitive design. ACM Interactions, 3 (6), 17-23.

Leidner, J. L., & Plachouras, V. (2017). Ethical by design: Ethics best practices for natural language processing. In Proceedings of the first ACL workshop on ethics in natural language processing (pp. 30-40). Valencia, Spain: Association for Computational Linguistics

Examination
Written examination / Duration of Examination: 60 minutes

Module NLProc-IRTM-B Information Retrieval and Text Mining *Information Retrieval and Text Mining*	6 ECTS / 180 h
(since SS24) Person responsible for module: Prof. Dr. Roman Klinger	

Contents:

- Boolean retrieval, inverted index
- Wild card queries, tolerant retrieval, spelling correction, query expansion
- Tokenization, Term normalization, Term statistics
- Efficient storage, indexing, compression, and memory consumption estimates
- Evaluation
- Ranking, Cosine similarity, TFIDF, Language models, Probabilistic retrieval
- Text classification, naive Bayes, SVM, MaxEnt Classifier, Neural Networks
- Flat and hierarchical clustering
- Web analysis, Page Rank

Learning outcomes:
Students learn how to build a search engine for text and evaluate it with various features. They learn to classify documents and group them according to their content. Students understand both the theoretical background of the methods and models and learn how to apply them.

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
The course develops a fundamental understanding of handling textual documents and large document collections. Knowledge of one higher programming language is strongly recommended, but not essential.	none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Information Retrieval and Text Mining **Mode of Delivery:** Lectures and Practicals **Lecturers:** Prof. Dr. Roman Klinger **Language:** English/Deutsch / English on demand **Frequency:** every summer semester	**4,00 Weekly Contact Hours**

Learning outcome:
Students learn how to build a search engine for text and evaluate it with various features. They learn to classify documents and group them according to their content. Students understand both the theoretical background of the methods and models and learn how to apply them.

Contents:

- Boolean retrieval, inverted index
- Wild card queries, tolerant retrieval, spelling correction, query expansion
- Tokenization, Term normalization, Term statistics

• Efficient storage, indexing, compression, and memory consumption estimates • Evaluation • Ranking, Cosine similarity, TFIDF, Language models, Probabilistic retrieval • Text classification, naive Bayes, SVM, MaxEnt Classifier, Neural Networks • Flat and hierarchical clustering • Web analysis, Page Rank **Literature:** Introduction to Information Retrieval, Manning, Raghavan, Schütze.	
Examination Written examination / Duration of Examination: 60 minutes	

Module NLProc-PGM4NLP-M Probabilistic Graphical Models for Natural Language Processing *Probabilistic Graphical Models for Natural Language Processing*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Roman Klinger	

Contents:

The course will provide an introduction to probabilistic graphical models, through the lens of natural language processing. Some topics covered will include

- Directed graphical models / Bayesian networks
- Undirected graphical models / Markov random fields
- Conditional random fields
- Causal modeling
- Structured prediction with graphical models
- Inference and sampling from graphical models
- Training methods for graphical models
- Neural graphical models.

Learning outcomes:

The goal of this course is to provide an introduction to probabilistic graphical models, and their use in natural language processing. We will start with formalisms for directed and undirected graphical models, before branching out into more specific applications for specific task domains in natural language processing. Students should leave with a basic understanding of how probabilistic graphical models work, and how they can be applied to tasks within natural language processing.

prerequisites for the module:

none

Recommended prior knowledge: Students should have prior experience with probability theory, statistics, or machine learning. Prior experience of natural language processing might be helpful, but is not required.		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Probabilistic Graphical Models for Natural Language Processing **Mode of Delivery:** Lectures and Practicals **Language:** English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**

Learning outcome:

The goal of this course is to provide an introduction to probabilistic graphical models, and their use in natural language processing. We will start with formalisms for directed and undirected graphical models, before branching out into more specific applications for specific task domains in natural language processing. Students should leave with a basic understanding of how probabilistic graphical models work, and how they can be applied to tasks within natural language processing.

Contents:

The course will provide an introduction to probabilistic graphical models, through the lens of natural language processing. Some topics covered will include

- Directed graphical models / Bayesian networks
- Undirected graphical models / Markov random fields
- Conditional random fields
- Causal modeling
- Structured prediction with graphical models
- Inference and sampling from graphical models
- Training methods for graphical models
- Neural graphical models.

Literature:

Klinger, R., & Tomanek, K. (2007). *Classical probabilistic models and conditional random fields*. TU, Algorithm Engineering.

Lafferty, J., McCallum, A., & Pereira, F. (2001, June). Conditional random fields: Probabilistic models for segmenting and labeling sequence data. In Icml (Vol. 1, No. 2, p. 3).

Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. MIT press.

Examination

Written examination / Duration of Examination: 60 minutes

Module PSI-AdvaSP-M Advanced Security and Privacy *Advanced Security and Privacy*	6 ECTS / 180 h 45 h Präsenzzeit 135 h Selbststudium

(since SS25)
Person responsible for module: Prof. Dr. Dominik Herrmann

Contents:
Information security and privacy are relevant in almost all information systems today. Many real-world use cases have complex security and privacy requirements involving multiple parties. Often there are multiple stakeholders with different, sometimes even contradictory interests. For instance, some use cases call for a solution that allows a service provider to process sensitive data without learning its content. In other cases it is not the content but some meta information such as location and usage intensity that has to be protected. And then there are scenarios where seemingly harmless pieces of data can be used to disclose or infer very personal pieces of information about an individual.

This module covers advanced techniques for information security and privacy that can be used to satisfy the complex requirements of practical systems. It builds upon the basic concepts in information security that are introduced in the module "Introduction to Security and Privacy" (PSI-IntroSP-B).

Learning outcomes:
This module is designed to bring students towards the research boundaries in the field of security and privacy technologies by covering a selection of contemporary topics in depth. The focus of the module is on technical safeguards that can be used by system designers and users to enforce properties such as confidentiality and integrity. Moreover, sophisticated attacks on security and privacy are explained.

Successful students will be able to explain attack strategies and defenses discussed in recent research papers. They will also be able to analyze whether a particular attack or defense is relevant in a specific scenario. Finally, they will be able to implement selected attacks and defenses with a programming language of their choice.

Remark:
This module is taught in English. It consists of a lecture and tutorials. During the course of the tutorials there will be theoretical and practical assignments (task sheets). Assignments and exam questions can be answered in English or German.

Lecture and tutorials are partially taught in form of a paper reading class. Participants are expected to read the provided literature in advance and participate in the discussions.

Workload breakdown:

- Lecture: 22.5 hours (2 hours per week)
- Tutorials: 22.5 hours (2 hours per week)
- Preparation and studying during the semester: 30 hours
- Assignments: 67.5 hours
- Preparation for the exam (including the exam itself): 37.5 hours

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
Participants should be familiar with basic concepts in information security and privacy, which can be acquired, for instance, by taking the module "Introduction to Security and Privacy" (PSI-IntroSP-B).	none

This includes basic knowledge about the commonly used security terminology, common types of malware and attacks, buffer overflows and related attacks, cryptography, network security, web security, and concepts of privacy. Moreover, participants should have practical experience with at least one scripting or programming language such as Python or Java. Module Introduction to Security and Privacy (PSI-IntroSP-B) - recommended		
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Advanced Security and Privacy **Mode of Delivery:** Lectures **Language:** English/German **Frequency:** every summer semester **Learning outcome:** cf. module description **Contents:** Selected topics: • Authentication techniques • Privacy on the web (e.g., online tracking) • Privacy enhancing technologies (e.g., Tor) • Security and privacy aspects of e-mail • Usability aspects in security and privacy • Ethical aspects information security • Advanced techniques in software security (e.g., symbolic execution) • Advanced cryptographic building blocks • Other current topics in privacy and security Some parts of the lecture are aligned with current events and recently published research. The selected topics are therefore subject to change. **Literature:** Selected books: • R. Anderson: Security Engineering • A. Shostack: Threat Modelling • J.-P. Aumasson: Serious Cryptography • W. Stallings: Computer Security: Principles and Practice • B. Schneier et al.: Cryptography Engineering • J. Erickson: Hacking: The Art of Exploitation • J. Katz & Y. Lindell: Introduction to Modern Cryptography • L. Cranor & S. Garfinkel: Security and Usability	**2,00 Weekly Contact Hours**
2. Tutorials for Advanced Security and Privacy **Mode of Delivery:** Practicals **Language:** English/German	**2,00 Weekly Contact Hours**

Frequency: every summer semester	

Examination Written examination / Duration of Examination: 110 minutes **Description:** The exam time includes a reading time of 20 minutes. The content that is relevant for the exam consists of the content presented in the lecture and tutorials (including the assignments) as well as the content of the discussed papers. The maximum number of points that can be achieved in the exam is 100. Participants that solve assignments can collect bonus points. Details regarding the total number of bonus points, the number of assignments, the number of points per assignment, and the type of assignments will be announced in the first lecture. If the points achieved in the exam are sufficient to pass the exam on its own (generally, this is the case when at least 50 points have been obtained), the bonus points will be added to the points achieved in the exam. The grade 1.0 can be achieved without the bonus points.	

Module PSI-DiffPriv-M Introduction to Differential Privacy *Introduction to Differential Privacy*	6 ECTS / 180 h
(since WS23/24) Person responsible for module: Prof. Dr. Dominik Herrmann further responsible : Graf, Christian Alexander	

Contents:

The protection of personal data is an organizational as well as a technical challenge. Privacy-by-design is a reasonable requirement that is anything but easy to implement. This is especially true if a system deals with data that is meant to be published.What is more, a mathematically meaningful definition of privacy has only been available for less than a decade.

The lecture addresses different concepts and approaches for de-identification and attacks on privacy of published datasets. Its focus is on bringing you an in-depth understanding of differential privacy. Theoretical foundations, concepts and examples of state-of-the-art algorithms are introduced and explored in greater depth by means of practical exercises.

Contents:

1. Fundamental concepts of Data Privacy (8h)

- Outline of topic and its impact on society and economy
- A short history of data privacy
- Privacy by design and privacy frameworks
- Attacker models and attack patterns
- Different approaches to define privacy and their downsides
- Motivation and conceptual idea of Differential Privacy

2. Mathematical Foundations (20h)

- a review of important concepts from analysis, stochastic and statistics
- properties of important distributions, e.g. Gauss-, Exponential- and Laplace-distribution
- some useful theorems

3. An overview over common methods used in statistical disclosure control (10h)

- common methods used for de-identification and approaches to define privacy in depth
- common methods used for disclosure risk estimation and determination of data utility

4. Algorithmic foundations of Differential Privacy (16h)

- generalized data base models
- randomized algorithms
- mathematical definition and properties of differential privacy
- measuring privacy-loss and utility
- post processing immunity of dp-methods
- alternative dp definitions

5. Different approaches to achieve Differential Privacy (10h)

For instance:

- DIP (distribution invariant differential privacy)

- GAN-approaches
- Existing Software frameworks for de-identification

Learning outcomes:

- understand and apply de-identification approaches and attacks on privacy
- understand and apply fundamental stochastic and statistical methods used in statistical disclosure control
- understand the mathematical concepts of differential privacy following Dwork et. al.
- apply examples for dp-algorithms in example scenarios
- know different approaches towards differential privacy

prerequisites for the module:
none

Recommended prior knowledge:		**Admission requirements:**
none		none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** Semester

Module Units

Lecture and Tutorial **Mode of Delivery:** Lectures and Practicals **Language:** English **Frequency:** every winter semester	**4,00 Weekly Contact Hours**

Contents:
see module description

Literature:
Provisional recommended literature:

- Claire McKay Bowen: Protecting Your Privacy in a Data-Driven World
- Dwork, Roth: The Algorithmic Foundations of Differential Privacy, Foundations and Trends in
- Theoretical Computer Science Vol. 9, Nos. 3–4 (2013)
- SPECIAL ISSUE: A New Generation of Statisticians Tackles Data Privacy, CHANCE Magazine, 33:4, 2020.

Literature on probability theory and statistics:

- Ludwig Fahrmeier, Rita Künstler, Iris Pigeot, Gerhard Tutz, Statistik - Der Weg zur Datenanalyse, 8. Auflage, Springer, 2016.
- William Feller, An Introduction to Probability Theory and Its Applications Vol.I, 3.Auflage, John Wiley & Sons, 1968.
- David J.C. MacKay: Information Theory, Inference, and Learning Algorithms., Cambridge University Press, 2003.

Examination / Duration of Examination: 90 minutes	

Module PSI-EDS-B Ethics for the Digital Society *Ethics for the Digital Society*		3 ECTS / 90 h
(since SS25) Person responsible for module: Prof. Dr. Dominik Herrmann		
Contents: This module introduces students to fundamental concepts of ethics and their application to techniques that shape the digital society. It discusses the influence of current and upcoming technologies and their implications from an ethical perspective. The lecture is accompanied by a series of case studies, which focus on a concrete problem that is to be analyzed by the participants. Topics include decision making in autonomous systems and systems that employ so-called artificial intelligence, the reliability and dependability of computer systems, and privacy aspects of information systems.		
Learning outcomes: Participants will be able to reflect on their actions as a scientist as well as a computer professional. They learn how to evaluate the trade-offs that are inherent in new technologies and how to design information systems in ways that support the needs of a digital society. Successful participants will obtain the ability to apply ethical thinking to novel problems and potential solutions.		
Remark: The module is taught in English unless all participants are fluent in German. There may be a small number of guest lectures that is taught in German. During the semester multiple case studies will be published. Participants will be asked to submit essays or solutions (small programs) discussing ethical aspects of those case studies. Essays will be peer-reviewed by other participants.		
prerequisites for the module: keine		
Recommended prior knowledge: keine		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Ethics for the Digital Society **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Dominik Herrmann **Language:** English/German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Learning outcome: cf. module description	
Contents: cf. module description	
Literature: • Ibo van de Poel and Lamber Royakkers: Ethics, Technology, and Engineering – an Introduction • Jay Quinn: Ethics for the Information Age	

• Herman T. Tavani: Ethics and Technology: Controversies, Questions, and Strategies for Ethical Computing	

Examination Written examination / Duration of Examination: 80 minutes **Description:** The exam time includes a reading time of 20 minutes. The exam questions will be in English. The questions can be answered in English or German. The content that is relevant for the exam consists of the content presented in the lecture and in the case studies. The maximum number of points that can be achieved in the exam is 100. Participants that solve assignments can collect bonus points. Details regarding the total number of bonus points, the number of assignments, the number of points per assignment, and the type of assignments will be announced in the first lecture. If the points achieved in the exam are sufficient to pass the exam on its own (generally, this is the case when at least 50 points have been obtained), the bonus points will be added to the points achieved in the exam. The grade 1.0 can be achieved without the bonus points.	

Module PSI-IntroSP-B Introduction to Security and Privacy *Introduction to Security and Privacy*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Dominik Herrmann	
Contents: This module introduces students to fundamental concepts in the fields of information security and the protection of privacy. It provides a broad overview over the most relevant topics from a technical perspective. The focus lies on practical issues that have to be considered when professional and personal information systems are built and operated.	
Learning outcomes: Successful students will know the mathematical background behind basic cryptographic primitives and be able to explain fundamental concepts of information security and privacy, including classical attacks and defenses. They will be able to apply their knowledge when implementing simple attack programs as well as building and operating defensive techniques.	
Remark: This module is taught in English. It consists of a lecture and tutorials. During the course of the tutorials there will be theoretical and practical assignments (task sheets). Assignments and exam questions can be answered in English or German. Workload breakdown: • Lecture: 22.5 hours (2 hours per week) • Tutorials: 22.5 hours (2 hours per week) • Preparation and studying during the semester: 30 hours • Assignments: 67.5 hours • Preparation for the exam (including the exam itself): 37.5 hours	
prerequisites for the module: none	
Recommended prior knowledge: It is strongly recommended to take this module only after successful completion of introductory courses on computer science on programming, algorithms, data structures, computer architecture, and operating systems. Prospective PSI-IntroSP-B participants should be familiar with fundamentals of computer architecture (binary representation of strings and numbers in computers, bitwise operators (such as XOR), operation of a CPU, basics of assembly language), operating systems (memory layout and process management), and computer networks (basic IP routing and addressing, TCP/IP connection establishment). Also, basic familiarity with the Linux command line is recommended. Moreover, basic familiarity with common web technologies (HTTP, HTML, JavaScript) as well as relational database systems and SQL is a recommended prerequisite.	**Admission requirements:** none

Finally, participants should have working knowledge in at least one programming language (e.g., Python, C, or Java) so that they can write small tools for automation purposes on demand. Module Introduction to Computer Science (Inf-Einf-B) - recommended Module Foundations of Computer Architecture and Operating Systems (Inf-GRABS-B) - recommended		
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Introduction to Security and Privacy — **2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Language: English
Frequency: every winter semester

Learning outcome:
cf. module description

Contents:
Selected topics

- Security Terminology (protection goals, attacker and attack types)
- Authentication and Authorization Fundamentals
- Software Security in C and Assembly (e.g., buffer overflows, selected defenses)
- Cryptography (e.g., historic ciphers, symmetric and asymmetric cryptosystems, Diffie-Hellman key exchange, TLS protocol)
- Network Security (spoofing, denial of service, authentication protocols, intrusion detection systems)
- Web Security (attacks and defenses related to the OWASP Top 10 including SQL injections and Cross Site Scripting)
- Privacy and Techniques for Data Protection (re-identification risks, anonymization networks, k-anonymity, the idea of differential privacy)

Literature:
Selected books:

- A. Shostack: Threat Modelling
- W. Stallings: Computer Security: Principles and Practice
- J. Erickson: Hacking: The Art of Exploitation

2. Introduction to Security and Privacy — **2,00 Weekly Contact Hours**

Mode of Delivery: Practicals
Language: English
Frequency: every winter semester

Contents:
In the tutorials, participants work on tasks and assignments to obtain practical skills related to the information security and privacy topics covered in the lecture.

Examination / Duration of Examination: 90 minutes **Description:** In the intermediate examination (e-exam), participants demonstrate that they master the practical skills acquired by completing the assignments.	

Examination Written examination / Duration of Examination: 120 minutes **prerequisites for module examination:** To be admitted to the final examination (e-exam), participants must have passed the intermediate exam (e-exam). **Description:** The exam time includes a reading time of 30 minutes. Details about the requirements for admission to the written examination will be announced in the first lecture. The content that is relevant for the exam consists of the content presented in the lecture and tutorials. The exam questions are in English. The exam questions can be answered in English or German.	

Module SNA-ASN-M Social Network Analysis *Analyse sozialer Netzwerke*	6 ECTS / 180 h
(since SS23) Person responsible for module: Prof. Dr. Oliver Posegga	
Contents: Social network analysis focuses on relationships between or among social entities. This course presents an introduction to various concepts, methods, and applications of social network analysis. The primary focus of these methods is the analysis of relational data measured on populations of social actors.	
Learning outcomes: Erwerb vertiefter Kenntnisse der Methoden und Modelle der Netzwerkanalyse. Die Studierenden verstehen die Bedeutung der Struktur sozialer Netzwerke für die Effektivität und Effizienz betrieblicher Arbeitsprozesse. Sie erlernen methodische Grundlagen der Analyse sozialer Netzwerke und die Bewertung ihrer strukturellen Eigenschaften. Sie sind in der Lage, ihre Kenntnisse auf Forschungsfragen der Wirtschaftsinformatik anzuwenden.	
Remark: The language of instruction in this course is German. However, the exam is available in English.	
prerequisites for the module: none	

Recommended prior knowledge: keine		**Admission requirements:** keine
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Analyse sozialer Netzwerke **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Oliver Posegga **Language:** German **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: Topics include an introduction to graph theory and the use of directed graphs and matrices to study actor interrelations; structural and locational properties of actors, such as centrality, prestige, and prominence; subgroups and cliques; equivalence of actors, including structural equivalence and, blockmodels;local analyses, including dyadic and triad analysis; and introduction to statistical global analyses, using models such as p* and their relatives. Methods are illustrated on a wide range of social network examples using both standard social network analysis software and special purpose computer programs.	
Literature: • Carrington PJ, Scott J, Wasserman S (2005) Models and Methods in Social Network Analysis. Cambridge University Press, New York. • Knoke D, Yang S (2007) Social Network Analysis, 2. Auflage. Sage Publications, Thousand Oaks	

- Newman MEJ (2010) Networks. An Introduction. Oxford University Press, Oxford.
- Wasserman S, Faust K (1994) Social Network Analysis: Methods and Applications. Cambridge University Press, New York.

2. Analyse sozialer Netzwerke

2,00 Weekly Contact Hours

Mode of Delivery: Practicals
Lecturers: Scientific Staff Wirtschaftsinformatik, insb. Soziale Netzwerke
Language: German
Frequency: every winter semester

Contents:

Die Inhalte der Vorlesung werden anhand von Übungsaufgaben und Fallbeispielen vertieft. Praktische Übungen werden unter Verwendung gängiger Software wie beispielsweise R und Gephi zur Analyse sozialer Netzwerke durchgeführt.

Literature:

- De Nooy, W., Mrvar, A., & Batagelj, V. (2018). Exploratory social network analysis with Pajek: Revised and expanded edition for updated software (Vol. 46). Cambridge university press.
- Grandjean, M. (2015). Gephi: Introduction to network analysis and visualization.
- Luke, D. A. (2015). A user's guide to network analysis in R (Vol. 72, No. 10.1007, pp. 978-3). New York: Springer.

Examination

Written examination / Duration of Examination: 90 minutes

Description:

In der Klausur werden die in Vorlesung und Übung behandelten Inhalte geprüft. Es können 90 Punkte erzielt werden.

Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.

Module SNA-NET-M Network Theory *Netzwerktheorie*	6 ECTS / 180 h

(since SS23)
Person responsible for module: Prof. Dr. Oliver Posegga

Contents:
Individuals and technology shape and are shaped by organizations. Individuals and organizations are also affected by sets of interlinked networks linking people, technology, organizations, knowledge and resources. In this world of networks and organizations, how do coordination, communication, power, tasks, goals, and information interact to affect group and organizational behavior and the impact of information technology on this behavior? How do we conceptualize, measure, and evaluate organizations and networks? How do we evaluate the impact of policies and technology on these organizations and networks especially given the fact that organizations and networks are dynamic?

Learning outcomes:
Die Studierenden kennen interdisziplinäre Theoriebeiträge zur Erklärung der Struktur und Dynamik sozialer Netzwerke und können das erworbene Wissen auf relevante Forschungsfragen der Wirtschaftsinformatik anwenden. Sie verstehen den Einfluss der Struktur eines Netzwerkes auf seine internen Prozesse und die Veränderung der Struktur eines Netzwerkes im Zeitverlauf.

Themenfelder:

- Theorien sozialer und komplexer Netzwerke
- Emergenz und Dynamik sozialer Netzwerke
- Agentenbasierte Modellierung und Spieltheorie
- Informationsverarbeitung in sozialen Netzwerken
- Netzwerkprozesse
- Wissensnetzwerke

Remark:
The language of instruction in this course is German. However, the exam is available in English.

prerequisites for the module:
none

Recommended prior knowledge: Kenntnisse aus dem Modul Analyse sozialer Netzwerke sind wünschenswert, jedoch nicht Voraussetzung	**Admission requirements:** keine

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Netzwerktheorie **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Oliver Posegga **Language:** German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**

Contents:
This course provides an overview of the dominant perspectives on organizations and networks from a macro perspective. Topics covered include knowledge

management, organizational design, organizational learning, organizational evolution and population ecology, organizational culture, organizations as complex systems, social and organizational networks, and dynamic network analysis. **Literature:** • Easley D, Kleinberg J (2010) Networks, Crowds, and Markets. Reasoning about a Highly Connected World. Cambridge University Press, New York • Goyal S (2009) Connections: An Introduction to the Economics of Networks, Princeton University Press, Princeton und Oxford • Jackson MO (2008) Social and Economic Networks. Princeton University Press, Princeton und Oxford • Kilduff M, Tsai W (2003) Social Networks and Organizations. Sage Publications, Thousand Oaks • Monge PR, Contractor N (2003) Theories of Communication Networks. Oxford University Press, New York	
2. Netzwerktheorie **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinformatik, insb. Soziale Netzwerke **Language:** German **Frequency:** every summer semester **Contents:** Die Inhalte der Vorlesung werden anhand von Übungsaufgaben und Fallbeispielen vertieft. Praktische Übungen werden unter Verwendung gängiger Software zur Analyse sozialer Netzwerke durchgeführt. **Literature:** Siehe Vorlesung.	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** In der Klausur werden die in Vorlesung und Übung behandelten Inhalte geprüft. Es können 90 Punkte erzielt werden. Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, wird zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.	

Module SNA-OSN-M Project Online Social Networks *Projekt zu Online Social Networks*	6 ECTS / 180 h

(since SS23)
Person responsible for module: Prof. Dr. Oliver Posegga

Contents:
This module is an introduction to the analysis of online social networks. The aim is twofold: to provide students with the tools necessary to undertake research into online networks, and to give an overview of the type of questions these data can answer.

Learning outcomes:
At the conclusion of the course, students should know not only how to calculate basic network metrics on pre-existing data sets, but also how to capture an online social network efficiently with the intent of answering a specific research question.

Further goals:

- Learn how the radical innovation process in small teams works
- Learn how to collaborate in multidisciplinary intercultural virtual teams
- Learn how to find trendsetter and trends on the Internet and social media
- Learn how to predict trends using SNA und statistical forecasting techniques

Remark:
The main language of instruction in this course is English. The written reports/seminar essay and the presentation have to be delivered in English.

prerequisites for the module:
none

Recommended prior knowledge:	**Admission requirements:**
We recommend attending at least one of the following courses: • Social Network Analysis (SNA-ASN-M) • Theories of Social Networks (SNA-NET-M)	keine

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

Online Social Networks **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Oliver Posegga **Language:** English/German **Frequency:** every winter semester	**4,00 Weekly Contact Hours**

Contents:
The course will define online networks, examine how they differ from offline social networks, and consider theoretical and methodological issues associated with their analysis. The sessions will explore different strategies to retrieve and analyze online network data, and present different empirical scenarios to which those tools have been applied.

Literature:

• Gloor, P. A. Swarm Creativity, Competitive Advantage Through Collaborative Innovation Networks. Oxford University Press, 2006 Further literature will be announced in the lecture.	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 4 months **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Die Gewichtung der Prüfungsleistungen Hausarbeit und Kolloquium wird zu Beginn der Lehrveranstaltung von der Dozentin bzw. dem Dozenten bekannt gegeben.	

Module SNA-WIM-B Knowledge- and Informationmanagement *Wissens- und Informationsmanagement*	6 ECTS / 180 h
(since SS23) Person responsible for module: Prof. Dr. Oliver Posegga	
Contents: Die Veranstaltung bietet eine Einführung in das betriebliche Wissens- und Informationsmanagement.	
Learning outcomes: Ziel der Veranstaltung ist die Vermittlung folgender Kenntnisse und Fähigkeiten: • Studierende kennen und verstehen relevante Begriffe, Modelle und Theorien des Wissens- und Informationsmanagements. • Studierende können die Modelle und Theorien zur Analyse und Bewertung verschiedener Wissens- und Informationsmanagementaspekte anwenden. • Studierende kennen verschiedene Wissens- und Informationsmanagementsysteme, die im inner- und überbetrieblichen Bereich zum Einsatz kommen. • Studierende verstehen, wie Wissensmanagementsysteme geeignet gestaltet und genutzt werden können. • Studierende verstehen die Bedeutung sozialer Netzwerke für das Wissensmanagement.	
prerequisites for the module: none	

Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Wissens- und Informationsmanagement **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Oliver Posegga **Language:** German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Contents: Vor dem Hintergrund der Globalisierung und Digitalisierung sowie der damit einhergehenden Intensivierung und Diversifizierung der Vernetzung erlangt das effektive und effiziente Management der Ressourcen Information und Wissen in Unternehmen strategischen Rang. Die Lehrveranstaltung befasst sich in diesem Kontext mit Zielen, Aufgaben, Systemen, Theorien und Methoden des Wissens- und Informationsmanagements. Dazu werden unter anderem die Wissensentwicklung, -verteilung, -nutzung, -bewertung, -bewahrung sowie der Wissenserwerb innerhalb von Unternehmen betrachtet.	
Literature:	

Dalkir, K. (2017): Knowledge Management in Theory and Practice. (3. Auflage). Cambridge, Massachusetts: The MIT Press. Weitere Literatur wird in der Veranstaltung bekannt gegeben.	
2. Wissens- und Informationsmanagement **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Wirtschaftsinformatik, insb. Soziale Netzwerke **Language:** German **Frequency:** every summer semester **Contents:** Die Übung Wissens- und Informationsmanagement dient der Vertiefung, Übung und Anwendung des in der Vorlesung vermittelten Stoffs. Dazu werden Aufgaben und Methoden des Wissens- und Informationsmanagements behandelt und Fallstudien in Gruppen bearbeitet. **Literature:** siehe Vorlesung	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** Durch die freiwillige Abgabe von semesterbegleitenden Studienleistungen können Punkte zur Notenverbesserung gesammelt werden, die auf die Klausur anrechenbar sind, sofern die Klausur auch ohne Punkte aus Studienleistungen bestanden ist. Zu Beginn der Lehrveranstaltung wird bekannt gegeben, ob Studienleistungen angeboten werden. Falls Studienleistungen angeboten werden, werden zu diesem Zeitpunkt auch die Anzahl, die Art, der Umfang und die Bearbeitungsdauer der Studienleistungen sowie die Anzahl an erreichbaren Punkten pro Studienleistung und in der Modulprüfung bekannt gegeben. Eine Bewertung von 1,0 kann auch ohne Punkte aus den Studienleistungen erreicht werden.	

Module SWT-ASV-M Applied Software Verification *Applied Software Verification*	6 ECTS / 180 h

(since WS24/25)
Person responsible for module: Prof. Dr. Gerald Lüttgen

Contents:
This module focuses on the increasingly important field of automated software verification, which aims at increasing the quality of today's complex computer systems. Students will be introduced to modern automated software verification and, in particular, to software model checking, and will be familiarised with a variety of important formal verification concepts, techniques and algorithms, as well as with state-of-the-art verification tools.

Learning outcomes:
On completion of this module, students will be able to thoroughly analyse software using modern software verification tools and understand the state-of-the-art techniques and algorithms that drive cutting-edge development environments offered by major software companies.

Remark:
The main language of instruction is English. The lectures and practicals may be delivered in German if all participating students are fluent in German.

The total workload of 180 hrs. is split approximately as follows:

- 30 hrs. attending lectures (Vorlesungen)
- 30 hrs. attending practicals (Übungen)
- 60 hrs. preparing and reviewing the lectures and practicals, including researching literature, studying material from additional sources and applying software tools
- 30 hrs. working on the assignment (Hausarbeit)
- 30 hrs. preparing for the colloquium (Kolloquium)

prerequisites for the module:
none

Recommended prior knowledge: Basic knowledge in algorithms and data structures, mathematical logic and theoretical computer science.	**Admission requirements:** none

Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Applied Software Verification **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Gerald Lüttgen **Language:** English **Frequency:** every summer semester	**2,00 Weekly Contact Hours**

Contents:
The lectures (Vorlesungen) will address the following topics in automated software verification: (i) state machines, linear-time properties and algorithms for state space exploration; (ii) LTL model checking; (iii) SAT solving and bounded model checking; (iv) decision procedures and SMT solving; (v) software

model checking; (vi) predicate abstraction. In addition, state-of-the-art software verification tools will be introduced. **Literature:** • Baier, C., Katoen, J.-P. Principles of Model Checking. MIT Press, 2008. • Clarke, E., Grumberg, O., Kroening, D., Peled, D. and Veith, H. Model Checking. 3rd. ed. MIT Press, 2018. • Huth, M. and Ryan, M. Logic in Computer Science. 2nd ed. Cambridge University Press, 2004. • Kroening, D. and Strichman, O. Decision Procedures: An Algorithmic Point of View. Springer, 2008. • Loeckx, J. and Sieber, K. The Foundations of Program Verification. 2nd ed. Wiley, 1987.	
2. Applied Software Verification **Mode of Delivery:** Practicals **Lecturers:** Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English **Frequency:** every summer semester **Contents:** Students will practice the various theoretical and practical concepts taught in the lectures (Vorlesungen) by applying them to solve verification problems using several modern model-checking tools, and also by engaging in pen-and-paper exercises. Emphasis will be put on presenting and discussing the solutions to the exercises by and among the students, within the timetabled practicals (Übungen). **Literature:** - see the corresponding lectures -	**2,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium / Duration of Examination: 20 minutes Duration of Coursework: 3 weeks **Description:** Assignment (Hausarbeit) consisting of questions that practice, review and deepen the knowledge transferred in the lectures and practicals (Vorlesungen und Übungen). The assignment is set in English language, while answers may be provided in either English or German. Colloquium (Kolloquium) consisting of questions testing the knowledge transferred in the lectures and practicals (Vorlesungen und Übungen), on the basis of the submitted solutions to the assignment (Hausarbeit). The colloquium can be held electively in English or German language.	

Module SWT-FSE-B Foundations of Software Engineering *Foundations of Software Engineering*	6 ECTS / 180 h
(since SS23) Person responsible for module: Prof. Dr. Gerald Lüttgen	
Contents: This module teaches the foundations of software engineering that are applicable to various kinds of software systems – from information systems to embedded systems. It focusses on technologies, notations and processes for system specification, design, implementation, and verification and validation.	
Learning outcomes: Students will receive an introduction to the common problems and paradigms in, and foundations of, software development. They will also gather conceptional and practical knowledge in the analysis, design and testing of software, with an emphasis on technical aspects of specifying, designing, implementing, verifying and validating software.	
Remark: The main language of instruction is English. The lectures and practicals may be delivered in German if all participating students are fluent in German. The total workload of 180 hrs. is split approximately as follows: • 45 hrs. attending lectures (Vorlesungen) • 30 hrs. reviewing the lectures, including researching and studying material from additional sources • 45 hrs. attending practicals (Übungen) • 30 hrs. preparing and reviewing the practicals, including researching and studying material from additional sources • 30 hrs. preparing for the written exam (Klausur)	
prerequisites for the module: none	

Recommended prior knowledge: Basic knowledge in Computer Science, as well as knowledge in programming in Java and in algorithms and data structures.		**Admission requirements:** none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Foundations of Software Engineering **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Gerald Lüttgen **Language:** English/German **Frequency:** every summer semester	**3,00 Weekly Contact Hours**
Contents: The lectures (Vorlesungen) provide an introduction to the foundations of software engineering, including commonly used technologies, notations and processes for all software engineering phases. In particular, conceptual and technical aspects of software specification, architecture and design, and verification and validation	

are discussed, such as the Unified Modeling Language (UML) and its semantics, model-driven and pattern-based development, and software testing. Students are also introduced to specific aspects of agile software development. **Literature:** • Sommerville, I. Software Engineering, 10th ed. Pearson, 2016. • Robertson, S. and Robertson, J. Mastering the Requirements Process, 3rd ed. Addison-Wesley, 2012. • Cohn, M. User Stories Applied. Addison-Wesley, 2004. • Stevens, P. and Pooley, R. Using UML - Software Engineering with Objects and Components, 2nd ed. Addison-Wesley, 2006. • Freeman, E., Robson, E., Sierra, K. and Bates, B. Head First Design Patterns, 2nd ed. O'Reilly, 2020. • Gamma, E., Helm, R., Johnson, R. and Vlissides, J. Design Patterns: Elements of Reusable Object-Oriented Design. Prentice Hall, 1994. Further literature will be announced in the lectures.	
2. Foundations of Software Engineering **Mode of Delivery:** Practicals **Lecturers:** Prof. Dr. Gerald Lüttgen, Scientific Staff Praktische Informatik, insbesondere Softwaretechnik und Programmiersprachen **Language:** English/German **Frequency:** every summer semester **Contents:** The practicals (Übungen) exercise and deepen the conceptual knowledge transferred via the lectures (Vorlesungen), and relay practical knowledge in software engineering. **Literature:** - see the corresponding lectures -	**3,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 120 minutes **Description:** Written exam (Klausur) consisting of questions that relate to the contents of the lectures (Vorlesungen) and practicals (Übungen) of this module. The written exam is set in English, while answers may be provided in either English or German. The exam is passed if at least 50% of the available points are reached.	

Module SYSNAP-OSE-M Operating Systems Engineering *Operating Systems Engineering*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Michael Engel	

Contents:

Operating systems and related system software such as hypervisors form the basis of today's computer systems. The design and implementation of the core parts of system software can have significant impact not only on the performance of a computer system, but also on other aspects such a safety, security, and energy efficiency. Thus, the design and implementation of operating systems is a highly relevant topic for students working in all areas of computer science, from small embedded systems to large virtualized Cloud infrastructures.

This module concentrates on the central part ("kernel") of an operating system, i.e. the part of the system running in a privileged processor mode that interacts directly with hardware. Based on seminal publications, students will investigate different architectures of kernels, such as monolithic, micro- and exokernels, hypervisors and also unikernels. Mechanisms and policies of operating systems will be analyzed with respect to their functional as well as non-functional properties. The analysis of mechanisms dependent on a specific processor architecture will be explained using the modern and open RISC-V processor architecture.

A central part of this module will consist of code reading and the development of pieces of code for a small operating system. Different aspects of operating system functionality will be demonstrated through existing code. Constraints of, extension possibilities for, as well as alternative approaches to implement a given functionality will be discussed; this discussion will then form the basis for the implementation of a given feature in the practical exercises. An example for this is the discussion of file systems; here, features of a given traditional inode-based file system will be discussed and analyzed and alternative implementations, such as log-structured file systems, will be investigated and implemented in a basic form.

Learning outcomes:

The module is designed to enable students to not only understand the internals of operating systems, but also learn about different aspects of their implementation and the interaction between hardware and software. Starting from a thorough analysis of the internals of modern operating systems, this module will continue to present and discuss novel and non-traditional approaches to operating systems in the second half of the semester.

Successful students will be able to understand design and implementation aspects of system software as well as to comprehend and critically analyze proposed new approaches from the literature. They will also be able to understand the structure of and extend a given operating system code base with new functionality and test as well as evaluate functional and non-functional properties of the implementation. By writing system-level code running directly on hardware (or a hardware emulator), students will also be able to gain a better understanding of the operation of hardware and its interaction with software.

prerequisites for the module:

none

Recommended prior knowledge:	**Admission requirements:**
Participants should be familiar with basic concepts of operating systems and computer architecture, e.g. as acquired by	-

taking the module "Grundlagen der Rechnerarchitektur und Betriebssysteme" (Inf-GRABS-B). In addition, knowledge of C programming, debugging using gdb, using the Unix command line, and software construction tools (e.g. make) are useful.		
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units

1. Operating Systems Engineering — **2,00 Weekly Contact Hours**

Mode of Delivery: Lectures
Lecturers: Prof. Dr. Michael Engel
Language: German/English
Frequency: every summer semester

Learning outcome:
cf. module description

Contents:
cf. module description

Literature:

- Russ Cox, Frans Kaashoek and Robert Morris, "xv6: a simple, Unix-like teaching operating system", MIT PDOS group 2020, https://pdos.csail.mit.edu/6.S081/2020/xv6/book-riscv-rev1.pdf
- Zhao Jiong, "A Heavily Commented Linux Source code", http://www.oldlinux.org/download/ECLK-5.0-WithCover.pdf
- Marshall Kirk McKusick et al., "The Design and Implementation of the 4.4 BSD Operating System", Addison-Wesley 1996, ISBN-13: 978-0132317924
- Uresh Vahalia, "Unix: the New Frontiers", Pearson 1996, ISBN-13: 978-0131019089
- John Lions, "Commentary on the 6th Edition Unix System", 1977, https://warsus.github.io/lions-/
- David Patterson and Andrew Waterman, "The RISC-V Reader: An Open Architecture Atlas", Strawberry Canyon 2017, ISBN-13: 978-0999249116$
- Andrew Waterman, Krste Asanovic and John Hauser (eds.), "The RISC-V Instruction Set Manual Volume II: Privileged Architecture", Document Version 20211203, https://github.com/riscv/riscv-isa-manual/releases/download/Priv-v1.12/riscv-privileged-20211203.pdf

In addition, selected papers will be provided.

2. Operating Systems Engineering — **2,00 Weekly Contact Hours**

Mode of Delivery:
Lecturers: Prof. Dr. Michael Engel
Language: German/English
Frequency: every summer semester

Learning outcome:
cf. module description

Contents:

cf. module description	

Examination Coursework Assignment and Colloquium / Duration of Examination: 30 minutes Duration of Coursework: 3 months **Description:** Oral examination concerning the topics discussed in the lecture, exercises and assignment. Students may choose English or German as the language for the oral examination. Examinations will take place at the end of the summer term or at the begin of the winter term (students may choose one of them). Students are assumed to work on a programming assignment ('schriftliche Hausarbeit') during the semester that is introduced at the beginning of the semester and uses the most important technologies discussed during the semester. **Note:** Without working on the programming assignment over the term students may run into problems during their oral examination (Kolloquium) as we discuss questions concerning topics from the lectures as well as from the assignment; questions about the assignment are based on the assignment solution programmed by the students.	

Module SYSNAP-PMAP-M Processor Microarchitecture and Performance *Processor Microarchitecture and Performance*	6 ECTS / 180 h
Person responsible for module: Prof. Dr. Michael Engel further responsible : Werner Haas	
Contents: Modern computer systems include high-performance processors which enable computationally demanding applications such as video and audio processing, handling of big data amounts or deep neural networks. Exploiting this performance potential for modern applications, however, is difficult, since increased performance levels could only be achieved by introducing additional complexity into the architecture of computer systems – for example, multiprocessor and multicore systems, multi-level memory hierarchies, and memory models with relaxed consistency. This course gives an insight into architectural details of modern processor architecture and their impact on non-functional properties. Whereas performance is the central topic of the course, additional non-functional properties such as energy consumption and security will be discussed. In addition to gaining theoretical insight into modern features of processor and system architecture, the course also discusses the interaction of software and hardware and how to optimize software for given architectural features.	
Learning outcomes: The module is designed to enable students to not only understand the internals of modern microprocessors and computer systems, but also learn about the non-functional properties involved and how the interaction between hardware and software relates to these. Starting with an overview of contemporary processors, this module will present and discuss different performance-improving aspects of processor architectures and their impact on software. Successful students will develop an understanding of modern processor architectures and the related systems as well as the resulting non-functional properties. They can comprehend and critically analyze existing and proposed new approaches from the literature. By writing code and analyzing the impact of different architectural features on the software, students will be able to gain a better understanding of the operation of hardware and its interaction with software and be able to optimize software for a given architecture and memory hierarchy.	
prerequisites for the module: verpflichtende Nachweise de	
Recommended prior knowledge: Fundamentals of computer architecture and operating systems, e.g. module PSI-EiRBS-B Operating Systems Engineering (SYSNAP-OSE-M) and/or Virtualization (SYSNAP-Virt-M)	**Admission requirements:** none
Frequency: every summer semester **Recommended semester:** **Minimal Duration of the Module:** 1 Semester	

Module Units	
1. Lecture Processor Microarchitecture and Performance **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Michael Engel	**2,00 Weekly Contact Hours**

Language: English/German **Frequency:** every summer semester **Learning outcome:** cf. module description **Contents:** 1 Intro/Recap: stored program arch, ISA, abstraction, iron law of performance 2 Simple pipelining: pipeline hazards, superscalar processing, exception handling 3 Caches: direct mapped, set/fully associative, memory hierarchy 4 Virtual memory: segmentation, paging, TLB, aliases/synonyms, VP/PP caches 5/6 Out of order execution – register renaming, Tomasulo algorithm – memory disambiguation, load/store queues 7/8 Branch prediction – branch history – branch targets 9 Symmetric multiprocessing: sequential consistency, cache coherence protocols 10 Virtualisation: processor modes, sensitive instructions, multi-level translation 11 Side channels: cache state, timing sources, resource contention 12 Transient execution attacks: Meltdown, Spectre, Retpoline **Literature:** John L. Hennessy, David A. Patterson Computer Architecture: A Quantitative Approach Morgan Kaufmann, 6th Edition 2017 ISBN-13: 978-0128119051 John Paul Shen, Mikko H. Lipasti Modern Processor Design: Fundamentals of Superscalar Processors Waveland Pr Inc, Reprint Edition 2013 ISBN-13: 978-1478607830	
2. Exercises Processor Microarchitecture and Performance **Mode of Delivery:** **Lecturers:** Prof. Dr. Michael Engel **Language:** English/German **Frequency:** every summer semester **Learning outcome:** cf. module description **Contents:** cf. module description **Literature:** cf. module description	**2,00 Weekly Contact Hours**
Examination Portfolio / Duration of Coursework: 3 months	

Module SYSNAP-Virt-M Virtualization *Virtualisierung*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Michael Engel	
Contents: Virtualization is the basis of a significant part of the Internet infrastructure today. It is used in different contexts such as system-level virtualization for co-hosting virtual machines in Cloud infrastructures or just-in-time translation of JavaScript code in web applications. This module discusses virtualization technologies on all layers of the hardware/software stack, from system-level virtualization to virtual machines for high-level languages. Based on publications and real-world code examples, students will investigate different architectures of virtual machines. The design and implementation of virtualization technologies will be analyzed through the investigation of real-world open-source code examples for common hardware, such as x86, ARM and RISC-V.	
Learning outcomes: The module is designed to enable students to understand the different approaches to virtualization and learn details about their design and implementation. Students will learn to analyze the advantages and disadvantages of virtualization on different layers of a computer system and will gain experience in isolation and security properties of virtualized systems. Successful students will be able to understand design and implementation aspects of different virtualization approaches as well as to comprehend and critically analyze proposed new approaches from the literature. They will also be able to understand the structure of and extend a given virtualization system code base with new functionality and test as well as evaluate functional and non-functional properties of the implementation.	
prerequisites for the module: none	
Recommended prior knowledge: Participants should be familiar with basic concepts of operating systems and computer architecture, e.g. as acquired by taking the module "Grundlagen der Rechnerarchitektur und Betriebssysteme" (Inf-GRABS-B). In addition, knowledge of C programming, debugging using gdb, using the Unix command line, and software construction tools (e.g. make) are useful.	**Admission requirements:** -
Frequency: every winter semester **Recommended semester:** **Minimal Duration of the Module:** 1 Semester	

Module Units	
1. Virtualisierung **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Michael Engel **Language:** German/English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Learning outcome: c.f. module description	
Contents:	

c.f. module description

Literature:

- Jim Smith and Ravi Nair,
  Virtual Machines: Versatile Platforms for Systems and Processes
  Morgan Kaufmann, 1st edition 2005, ISBN-13: 978-1558609105
- Steven Hand, Andrew Warfield, Keir Fraser, Evangelos Kotsovinos, Dan Magenheimer
  Are Virtual Machine Monitors Microkernels Done Right?
  Proceedings of HotOS'05, 2005
- Gernot Heiser, Volkmar Uhlig and Joshua LeVasseur,
  Are virtual-machine monitors microkernels done right?,
  ACM SIGOPS Oper. Syst. Rev., vol. 40, number 1, 2006
- Barham, Paul, et al.,
  Xen and the art of virtualization,
  ACM SIGOPS operating systems review 37.5 (2003): 164-177
- Heiser, Gernot, and Kevin Elphinstone.
  L4 microkernels: The lessons from 20 years of research and deployment,
  ACM Transactions on Computer Systems (TOCS) 34.1 (2016): 1-29
- Engler, Dawson R., M. Frans Kaashoek, and James O'Toole Jr.,
  Exokernel: An operating system architecture for application-level resource management,
  ACM SIGOPS Operating Systems Review 29.5 (1995): 251-266
- Aycock, John,
  A brief history of just-in-time,
  ACM Computing Surveys (CSUR) 35.2 (2003): 97-113

Additional selected papers will be provided as required.

2. Virtualisierung — **2,00 Weekly Contact Hours**

Mode of Delivery:
Lecturers: Prof. Dr. Michael Engel
Language: German/English
Frequency: every winter semester

Learning outcome:
c.f. module description

Contents:
c.f. module description

Examination
Coursework Assignment and Colloquium / Duration of Examination: 30 minutes
Duration of Coursework: 3 months

Description:
Oral examination concerning the topics discussed in the lecture, exercises and assignment. Students may choose English or German as the language for the oral examination. Examinations will take place at the end of the winter term or at the begin of the summer term (students may choose one of them).

Students are assumed to work on a programming assignment ('schriftliche Hausarbeit') during the semester that is introduced at the beginning of the semester and uses the most important technologies discussed during the semester.	

Module VIS-IVVA-M Advanced Information Visualization and Visual Analytics *Advanced Information Visualization and Visual Analytics*	6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Fabian Beck	
Contents: The course discusses methods for interactive information visualization and systems for explorative visual analysis. Visualizations blend with algorithmic solutions and get adopted to domain-specific needs. Giving a research-oriented perspective, the design and evaluation of such methods is the focus of the course, as well as their practical and interdisciplinary application in various fields.	
Learning outcomes: The students recognize the possibilities and limitations of data visualization and are able to apply visualization methods to concrete application examples. They understand the foundations of visual perception and cognition as well as their implications for the visual representation of data. They have a sound overview of possibilities for the visual representation of abstract data and are able to adapt visualization techniques to new problems and justify design decisions. On a conceptual level, they are able to integrate visualization techniques with interaction techniques and algorithmic solutions and design visual analytics solutions. They can evaluate visualization techniques in quantitative and qualitative user studies.	
Remark: The workload for this module typically is as follows: • Lecture and exercise sessions: 45h • Preparation and review of the lecture: 30h • Work on exercises and assignments: 75h • Preparation for the exam: 30h	
prerequisites for the module: none	
Recommended prior knowledge: Basic knowledge in information visualization (e.g., as provided through VIS-GIV-B) is recommended; knowledge in programming, algorithms and data structures, human-computer-interaction, and machine learning and data science can be beneficial.	**Admission requirements:** none

Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Advanced Information Visualization and Visual Analytics **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Fabian Beck **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: See module description	

Literature: Further material and reading will be announced in the course.	
2. Advanced Information Visualization and Visual Analytics **Mode of Delivery:** Practicals **Lecturers:** N.N. **Language:** English **Frequency:** every winter semester	**2,00 Weekly Contact Hours**
Contents: In the exercise sessions, lecture contents are expanded upon and their application is practiced.	

Examination Written examination / Duration of Examination: 90 minutes **Description:** By voluntarily handing in graded assignments (semesterbegleitende Studienleistungen) during the semester, points can be collected to improve the grade, which can be credited to the exam, provided that the exam is also passed without points from assignments. At the beginning of the course, it will be announced whether graded assignments are offered. If offered, the number, type, scope and processing time of the assignments as well as the number of achievable points per assignment and in the module examination will also be announced at this time. A grade of 1.0 can also be achieved without points from the assignments.	

Module WI-Projekt-B Bachelor Project in Information Systems *Bachelorprojekt aus der Fächergruppe Wirtschaftsinformatik*		6 ECTS / 180 h
(since WS21/22) Person responsible for module: Prof. Dr. Sven Overhage		
Contents: In an information systems project, specific questions from sub-areas of business informatics are researched and discussed.		
Learning outcomes: The course also prepares students to work systematically in teams and promotes key skills such as presenting work results and working on projects in a goal-oriented manner.		
prerequisites for the module: none		
Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelor Project in Information Systems **Mode of Delivery:** Practicals **Language:** German **Frequency:** every semester	**4,00 Weekly Contact Hours**

Examination Coursework Assignment and Colloquium **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung. **Description:** A term paper and a presentation in a colloquium are required as part of the examination. The deadline for the term paper and the duration of the examination will be announced by the supervisor of the project at the beginning of the course.	

Module WI-Seminar-B Bachelor Seminar in Information Systems *Bachelorseminar aus der Fächergruppe Wirtschaftsinformatik*	3 ECTS / 90 h
(since WS24/25) Person responsible for module: Prof. Dr. Sven Overhage	
Contents: Eigenständige Erarbeitung und Präsentation eines Themas aus dem Fachgebiet der Wirtschaftsinformatik mit wissenschaftlichen Methoden.	
Learning outcomes: Kompetenzerwerb in den Bereichen kritische und systematische Literaturanalyse, Strukturierung komplexer Sachverhalte, bewertender Vergleich konkurrierender Ansätze. Professionelle Präsentation von Fachthemen. Erlernen des Verfassens wissenschaftlicher Arbeiten.	
Remark: Es ist ein Bachelorseminar aus dem Fachgebiet der Wirtschaftsinformatik zu wählen. Die Seminarthemen werden über die jeweiligen Homepages der Lehrstühle bekannt gegeben.	
prerequisites for the module: none	

Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Bachelorseminar **Mode of Delivery:** Seminar **Language:** German/English **Frequency:** every semester	**2,00 Weekly Contact Hours**
Literature: Die Literatur wird zu Beginn eines Seminars bekannt gegeben.	

Examination Coursework Assignment with presentation **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung **Description:** Als Prüfungsleistung ist eine Hausarbeit sowie ein Referat zu erbringen. Alternativ kann die Prüfungsleistung auf Hausarbeit mit Kolloquium festgelegt werden. Die Bearbeitungsfrist der Hausarbeit und die Prüfungsdauer des Referats bzw. des Kolloquiums werden zu Beginn einer jeden Lehrveranstaltung von der Seminarleiterin bzw. dem Seminarleiter bekannt gegeben.	

Module WI-Seminar1-M Master Seminar in Information Systems *Masterseminar aus der Fächergruppe Wirtschaftsinformatik*	3 ECTS / 90 h
(since WS24/25) Person responsible for module: Prof. Dr. Sven Overhage	
Contents: Eigenständige Erarbeitung und Präsentation eines Themas aus einem Fachgebiet der Wirtschaftsinformatik mit wissenschaftlichen Methoden.	
Learning outcomes: Kompetenzerwerb in den Bereichen kritische und systematische Literaturanalyse, Strukturierung komplexer Sachverhalte, bewertender Vergleich konkurrierender Ansätze. Professionelle Präsentation von Fachthemen. Vertiefen des Verfassens wissenschaftlicher Arbeiten.	
Remark: Es ist ein Masterseminar aus dem Fachgebiet der Wirtschaftsinformatik zu wählen. Die Seminarthemen werden über die jeweiligen Homepages der Lehrstühle bekannt gegeben.	
prerequisites for the module: none	

Recommended prior knowledge: none		**Admission requirements:** none
Frequency: every semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
Masterseminar **Mode of Delivery:** Seminar **Language:** German/English **Frequency:** every semester	**2,00 Weekly Contact Hours**
Contents: Die Inhalte der Masterseminare werden von jedem anbietenden Lehrstuhl festgelegt und bekannt gegeben.	
Literature: Die Literatur wird zu Beginn eines Seminars bekannt gegeben.	

Examination Coursework Assignment with presentation **prerequisites for module examination:** Regelmäßige Teilnahme an der Lehrveranstaltung. **Description:** Als Prüfungsleistung ist eine Hausarbeit sowie ein Referat zu erbringen. Alternativ kann die Prüfungsleistung auf Hausarbeit mit Kolloquium festgelegt werden. Die Bearbeitungsfrist der Hausarbeit und die Prüfungsdauer des Referats bzw. des Kolloquiums werden zu Beginn einer jeden Lehrveranstaltung von der Seminarleiterin bzw. dem Seminarleiter bekannt gegeben.	

Module xAI-DL-M Deep Learning *Deep Learning*		6 ECTS / 180 h
(since WS24/25) Person responsible for module: Prof. Dr. Christian Ledig		
Contents: Deep Learning is a form of machine learning that learns hierarchical concepts and representations directly from data. Enabled by continuously growing dataset sizes, compute power and rapidly evolving open-source frameworks Deep Learning based AI systems continue to set the state of the art in many applications and industries. The course will provide an introduction to the most relevant techniques in the field of Deep Learning and a broad range of its applications.		
Learning outcomes: In this course students will learn/recap some fundamentals from mathematics and machine learning that are critical for the introduction of the concept of Deep Learning. Participants will learn about various foundational technical aspects including optimization and regularization strategies, cost functions and important network architectures such as Convolutional Networks. Students will further get an insight into more advanced concepts such as sequence modelling and generative modelling. Participants will further learn about representative architectures of important algorithm categories, e.g., classification, detection, segmentation, some of their concrete use cases and how to evaluate them. The lecture is accompanied by exercises and assignments that will help participants develop practical, hands-on experience. In those exercises students will learn how to implement and evaluate Deep Learning algorithms using Python and its respective commonly used libraries.		
Remark: The lecture is conducted in English. The workload of this module is expected to be roughly as follows: • Lecture: 22.5h (equals the 2 SWS) • Preparation of lectures and analysis of further sources: 30h (over the 15 weeks term) • Exercise classes accompanying lecture: 22.5h (equals the 2 SWS) • Work on the actual assignments: 75h (over the 15 weeks term) • Preparation for exam: 30h		
prerequisites for the module: none		
Recommended prior knowledge: Strongly recommended: Good working knowledge of programming (in particular Python), Mathematics for Machine Learning [xAI-MML] Further recommended (or similar): Bachelorproject Erklärbares Maschinelles Lernen [xAI-Proj-B], Lernende Systeme / Machine Learning [KogSys-ML-B], Einführung in die Künstliche Intelligenz / Introduction to AI [KogSys-KI-B], Algorithmen und Datenstrukturen [AI-AuD-B]		**Admission requirements:** none
Frequency: every winter semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Deep Learning **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Christian Ledig **Language:** English/German **Frequency:** every winter semester **Learning outcome:** c.f. module description **Contents:** The lecture will be held in English. The following is a selection of topics that will be addressed in the course • Relevant concepts in linear algebra, probability and information theory • Deep feedforward networks • Convolutional Neural Networks • Regularization, Batch Normalization • Optimization (Backpropagation, Stochastic Gradient Decent) and Cost Functions • Classification (binary, multiclass, multilabel) • Object Detection & Segmentation • Generative Modelling • Attention mechanisms & Transformer Networks • Evaluation of ML approaches **Literature:** • Ian Goodfellow, Yoshua Bengio, and Aaron Courville: Deep Learning, MIT Press, 2016 • Zhang, Lipton, et al.: Dive into Deep Learning (https://d2l.ai/) Further literature will be announced at the beginning of the course.	**2,00 Weekly Contact Hours**
2. Deep Learning **Mode of Delivery:** Practicals **Lecturers:** N.N. **Language:** English/German **Frequency:** every winter semester **Learning outcome:** see module description **Contents:** Further exploration of concepts discussed in the lecture, often accompanied by assigments and programming exercises implemented in Python and the corresponding machine/deep learning libraries. **Literature:** see lecture description	**2,00 Weekly Contact Hours**

Examination	
Written examination / Duration of Examination: 90 minutes **Description:**	

The content that is relevant for the exam consists of the content presented in the lecture and exercises/tutorials (including the assignments) as well as additional content of the discussed literature, which will be highlighted. Participants can collect bonus points by working on and solving the assignments discussed during the exercises/tutorials. Details regarding the number of assignments, the number of points per assignment, and the type of assignments will be announced in the lecture. If the points achieved in the exam are sufficient to pass the exam on its own, the bonus points (at most 20% of the maximum achievable points in the exam) will be added to the points achieved in the exam. The grade 1.0 can be achieved without the bonus points.	

Module xAI-MML-B Mathematics for Machine Learning *Mathematics for Machine Learning*	6 ECTS / 180 h

(since SS25)
Person responsible for module: Prof. Dr. Christian Ledig

Contents:
The course aims to establish a common mathematical foundation for the further study of advanced machine learning techniques. The content is selected specifically to be most relevant for students interested in machine learning problems and covers a broad range of concepts from, e.g., linear algebra, vector calculus, probability theory, statistics, and optimization.

Learning outcomes:
In this course students will learn fundamental mathematical concepts that are important prerequisites for the deeper understanding of the field of machine learning. The overarching goal of this course is to build a mathematical foundation by selectively covering the most essential mathematical concepts form a broad range of mathematical disciplines. Dependent on previous background, students will get the chance to learn critical ML-relevant mathematics for the first time or consolidate concepts that have been partially covered in their previous curriculum.

The lecture is accompanied by exercises and assignments that will help participants develop both theoretical and practical experience. In those exercises students will get the opportunity to learn how to apply and prove theoretical concepts as well as implement some concrete algorithms in Python and its respective commonly used libraries.

Course is also open to MSc students with the goal of building / consolidating their mathematical foundation with a focus on machine learning applications.

Remark:
The lecture is conducted in English. The workload of this module is expected to be roughly as follows:

- Lecture: 22.5h (equals the 2 SWS)
- Preparation of lectures and analysis of further sources: 30h (over the 15 weeks term)
- Exercise classes accompanying lecture: 22.5h (equals the 2 SWS)
- Work on the actual assignments: 75h (over the 15 weeks term)
- Preparation for exam: 30h

prerequisites for the module:
none

Recommended prior knowledge:		**Admission requirements:**
No specific prior knowledge is required.		none
Frequency: every summer semester	**Recommended semester:**	**Minimal Duration of the Module:** 1 Semester

Module Units	
1. Mathematics for Machine Learning **Mode of Delivery:** Lectures **Lecturers:** Prof. Dr. Christian Ledig **Language:** English/German **Frequency:** every summer semester	**2,00 Weekly Contact Hours**
Learning outcome:	

c.f. module description **Contents:** The lecture will be held in English. The following is a selection of topics that will be addressed in the course • Linear Algebra (e.g., vector spaces, span, basis, rank) • Analytic Geometry (e.g., norms, inner product, projections) • Matrix decompositions (e.g., Eigenvectors, SVD) • Vector calculus (e.g., derivatives, Taylor series) • Information Theory (e.g., entropy, KL divergence) • Probability theory and distributions • Statistics (e.g., estimators, tests) • Optimization (e.g., gradient based) • Machine Learning Problems (e.g., Density estimation, Dimensionality Reduction) **Literature:** • Marc. Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong: Mathematics for Machine Learning, Cambridge University Press, 2020 Further literature will be announced at the beginning of the course.	
2. Mathematics for Machine Learning **Mode of Delivery:** Practicals **Lecturers:** N.N. **Language:** English/German **Frequency:** every summer semester **Learning outcome:** see module description **Contents:** Further exploration of concepts discussed in the lecture by specific assigments and some programming exercises implemented predominantly in Python. **Literature:** see lecture description	**2,00 Weekly Contact Hours**

Examination Written examination / Duration of Examination: 90 minutes **Description:** The content that is relevant for the exam consists of the content presented in the lecture and exercises/tutorials (including the assignments) as well as additional content of the discussed literature, which will be highlighted.	

ID	Module	Semester	ECTS	Weekly Contact Hours	Examination
	International studies taught in English (on demand)				
	Find all courses taught in English (on demand) below. Please note: Lectureres will usally ask in the first session whether it should be held in German or English. It is possible, however, they will conduct their session in German. Please don't be afraid to demand continuing in English.				
	Subject Group: Applied Computer Science				
	Subject: Projects & Seminars of Applied Computer Science Group Projects & seminars of Applied Computer Science Group are not listed with their exact but with an abstract title in the module handbook (e.g. AI-Seminar1-B instead of KogSys-Sem-B). There might be some which are taught in English. Please see the chairs' web pages for further information (https://www.uni-bamberg.de/en/wiai/subject-groups/faecher/) or UnivIS (https://univis.uni-bamberg.de/). You will find five different types: • Seminar for Bachelor's studies (3 ECTS) • Project for Bachelor's studies (6 ECTS) • Seminar for Master's Studies (3 ECTS) • Project for Master's Studies (small, 6 ECTS) • Project for Master's Studies (large, 15 ECTS)				
AI-Seminar1-B	Bachelor Seminar 1 in Applied Computer Science	every semester(1)	3	2 Seminar	Coursework Assignment with presentation
AI-Projekt1-B	Bachelor Project 1 in Applied Computer Science	every semester(1)	6	4	Coursework Assignment and Colloquium
AI-Sem1-M	Master Seminar Applied Computer Science	every semester	3	2 Seminar	Coursework Assignment with presentation
AI-6Proj1-M	Project 1 in the subject area Applied Computer Science	every semester	6	4	Coursework Assignment and Colloquium
AI-Proj1-M	Project 1 in Applied Computer Science	every semester(1)	15	6 Practicals	Coursework Assignment and Colloquium
	Subject: AI Systems Engineering				
AISE-ETH	Ethics and Epistemology of AI		6	2 Lectures	Portfolio

		every summer semester(1)		2 Practicals	
AISE-FTAIP-B	Frontier Topics in AI and Philosophy	every winter semester(1)	6	2 Lectures 2 Practicals	Written examination 90 minutes
AISE-PLM-V	Computational Metaphysics - Mechanizing Principia Logico-Metaphysica	annually(1)	3	2 Lectures	Oral examination 30 minutes
AISE-UL	Universal Logic & Universal Reasoning	every winter semester(1)	6	2 Lectures and Practicals 2 Practicals	Written examination (AISE-UL: Universal Logic & Universal Reasoning (Universelle Logik & Universelles Schließen))
	Subject: Computer Graphics and its Foundations				
CG-VRAR-M	Virtual Reality / Augmented Reality	every summer semester	6	2 Lectures 2 Practicals	Written examination
	Subject: Explainable Machine Learning				
xAI-DL-M	Deep Learning	every winter semester(1)	6	2 Lectures 2 Practicals	Written examination 90 minutes
xAI-MML-B	Mathematics for Machine Learning	every summer semester(1)	6	2 Lectures 2 Practicals	Written examination 90 minutes
	Subject: Fundamentals of Natural Language Processing				
NLProc-ALV-B	Natural Language Understanding	every winter semester(1)	6	4 Lectures and Practicals	Written examination 60 minutes
NLProc-ANLP-M	Applied Natural Language Processing	every semester(1)	6	2 Seminar 2 Seminar 2 Seminar 2 Seminar 2 Lectures and Practicals 2	Internship report

NLProc-EA-M	Emotion Analysis	every semester(1)	6	0	Coursework Assignment and Colloquium
NLProc-ILT-M	Impact of Language Technology	every winter semester(1)	6	4 Lectures and Practicals	Written examination 60 minutes
NLProc-IRTM-B	Information Retrieval and Text Mining	every summer semester(1)	6	4 Lectures and Practicals	Written examination 60 minutes
NLProc-PGM4NLP-M	Probabilistic Graphical Models for Natural Language Processing	every winter semester(1)	6	4 Lectures and Practicals	Written examination 60 minutes
	Subject: Human-Computer Interaction				
HCI-DFM-M	Design and Research Methods of Human-Computer Interaction	every summer semester	6	2 Lectures 2 Practicals	Oral examination Written examination 90 minutes
HCI-DISTP-B	Design of Interactive Systems: Theory and Practice	every summer semester(1)	6	1 Lectures and Practicals 1 Practicals	Colloquium 30 minutes Colloquium 30 minutes
HCI-DR-M	Design Research	every winter semester(1)	6	2 Lectures and Practicals	Colloquium 30 minutes
HCI-IS-B	Interactive Systems	every winter semester	6	2 Lectures 2 Practicals	Written examination 90 minutes Oral examination
HCI-KS-B	Cooperative Systems	every summer semester	6	2 Lectures 2 Practicals	Oral examination Written examination 90 minutes
HCI-MCI-M	Human-Computer Interaction	every winter semester	6	2 Lectures 2 Practicals	Oral examination Written examination 90 minutes
HCI-US-B	Ubiquitous Systems	every winter semester	6	2 Lectures 2 Practicals	Oral examination Written examination

					90 minutes
HCI-Usab-M	Usability in Practice	every summer semester	6	4 Practicals	Coursework Assignment and Colloquium 4 months 30 minutes
	Subject: Information Visualization				
VIS-IVVA-M	Advanced Information Visualization and Visual Analytics	every winter semester(1)	6	2 Lectures 2 Practicals	Written examination 90 minutes
	Subject: Natural Language Generation and Dialogue Systems				
DS-ConvAI-M	Advanced Dialogue Systems and Conversational AI	every summer semester(1)	6	2 Lectures 2 Practicals	Oral examination 30 minutes
	Subject Group: Computer Science				
Inf-DM-B	Discrete Modelling	every winter semester(1)	9	6 Lectures and Practicals	Written examination
	Subject: Projects & Seminars of Computer Science Group Projects & seminars of Computer Science Group are not listed with their exact but with an abstract title in the module handbook (e.g. Inf-Sem-M instead of MOBI-Sem-M). There might be some which are taught in English. Please see the chairs' web pages for further information (https://www.uni-bamberg.de/en/wiai/subject-groups/faecher/) or UnivIS (https://univis.uni-bamberg.de/). You will find four different types: • Seminar for Bachelor's studies (3 ECTS) • Project for Bachelor's studies (6 ECTS) • Seminar for Master's Studies (3 ECTS) • Project for Master's Studies (6 ECTS)				
Inf-Seminar1-B	Bachelor Seminar 1 in Computer Science	every semester	3	2 Seminar	Coursework Assignment with presentation

Inf-Projekt1-B	Bachelor Project 1 in Computer Science	every semester	6	4	Coursework Assignment and Colloquium
Inf-Sem-M	Master's Seminar in Computer Science	every semester	3	2 Seminar	Coursework Assignment with presentation
Inf-Proj-M	Master's Project in Computer Science	every semester	6	4	Coursework Assignment and Colloquium
	Subject: Algorithms and Complexity Theory				
AlgoK-AK-B	algorithms and complexity	every summer semester(1)	6	2 Lectures and Practicals	Oral examination
AlgoK-ALDAI-B	Algorithms and logic in data science and AI	every winter semester(WS25/26)	6	2	Sonstiges
AlgoK-TAG	Baumzerlegungen, Algorithmen und Spiele	every winter semester(1)	6	4 Lectures and Practicals	Sonstiges 90 minutes
	Subject: Data Engineering				
DT-CPP-B	Introduction into Systems Programming in C++	every winter semester(1)	6	4 Lectures and Practicals	Portfolio 4 months
DT-CPP-M	Advanced Systems Programming in C++ (Master)	every winter semester(1)	6	4 Lectures and Practicals	Portfolio 4 months
DT-DBCPU-M	Database Systems for modern CPU	every summer semester(1)	6	4 Lectures and Practicals	Written examination 90 minutes
	Subject: Experimental Software Engineering				
ESE-ESEng-M	Evidence-based Software Engineering	no value	6	2 2	Sonstiges
ESE-SRE-B	Software Requirements Engineering	every summer semester	6	2 Lectures 2 Practicals	Sonstiges
	Subject: Foundations of Computer Science				
GdI-CSNL-M	Computational Semantics of Natural Language		6	4 Lectures and Practicals	Portfolio

		every summer semester(1)			80 minutes
GdI-FPRS-M	Functional Programming of Reactive Systems	every summer semester	6	2 Lectures 2 Practicals	Written examination 90 minutes Oral examination 30 minutes
GdI-GTI-B	Machines and Languages	every summer semester	6	2 Lectures 2 Practicals	Sonstiges
GdI-IFP-M	Introduction to Functional Programming	every winter semester	6	2 Lectures 2 Practicals	Written examination 90 minutes
	Subject: Mobile Software Systems/Mobility				
MOBI-ADM-M	Advanced Data Management	every summer semester(1)	6	2 Lectures 2 Practicals	Written examination 75 minutes
MOBI-DSC-M	Data Streams and Complex Event Processing	every winter semester(1)	6	2 Lectures 2 Practicals	Oral examination 15 minutes Written examination 60 minutes
	Subject: Privacy and Security in Information Systems				
PSI-AdvaSP-M	Advanced Security and Privacy	every summer semester(1)	6	2 Lectures 2 Practicals	Written examination 110 minutes
PSI-DiffPriv-M	Introduction to Differential Privacy	every winter semester(1)	6	4 Lectures and Practicals	90 minutes
PSI-EDS-B	Ethics for the Digital Society	every winter semester	3	2 Lectures	Written examination 80 minutes
PSI-IntroSP-B	Introduction to Security and Privacy	every winter semester(1)	6	2 Lectures 2 Practicals	90 minutes Written examination

					120 minutes
	Subject: Software Technologies				
SWT-ASV-M	Applied Software Verification	every summer semester	6	2 Lectures 2 Practicals	Coursework Assignment and Colloquium 3 weeks 20 minutes
SWT-FSE-B	Foundations of Software Engineering	every summer semester	6	3 Lectures 3 Practicals	Written examination 120 minutes
	Subject: Systems Programming				
SYSNAP-OSE-M	Operating Systems Engineering	every summer semester(1)	6	2 Lectures 2	Coursework Assignment and Colloquium 3 months 30 minutes
SYSNAP-PMAP-M	Processor Microarchitecture and Performance	every summer semester(1)	6	2 Lectures 2	Portfolio 3 months
SYSNAP-Virt-M	Virtualization	every winter semester(1)	6	2 Lectures 2	Coursework Assignment and Colloquium 3 months 30 minutes
	Subject Group: Information Systems				
	Subject: Projects & Seminars of Information Systems Group				
	Bachelor's Projects & seminars of Information Systems Group are not listed with their exact but with an abstract title in the module handbook (e.g. WI-Seminar-B instead of IIS-Sem-B). There might be some which are taught in English. Please see the chairs' web pages for further information (https://www.uni-bamberg.de/en/wiai/subject-groups/faecher/) or UnivIS (https://univis.uni-bamberg.de/). You will find two different types:				

	• Seminar for Bachelor's studies (3 ECTS) • Project for Bachelor's studies (6 ECTS)				
WI-Seminar-B	Bachelor Seminar in Information Systems	every semester	3	2 Seminar	Coursework Assignment with presentation
WI-Projekt-B	Bachelor Project in Information Systems	every semester	6	4 Practicals	Coursework Assignment and Colloquium
WI-Seminar1-M	Master Seminar in Information Systems	every semester	3	2 Seminar	Coursework Assignment with presentation
	Subject: AI Engineering in Companies				
AIC-HYIN-M	Hybrid Intelligence	every summer semester(1)	6	4 Lectures and Practicals	Coursework Assignment and Colloquium 3 months 60 minutes
AIC-SPRO-M	Research Project: Digital Society and AI-based Systems	every summer semester(1)	6	4	Coursework Assignment and Colloquium 3 months 60 minutes
	Subject: Energy Efficient Systems				
EESYS-ADAML-M	Applied Data Analytics and Machine Learning in R	every winter semester	6	2 Lectures 2 Practicals	Written examination 90 minutes
EESYS-ES-M	Energy Efficient Systems	every summer semester	6	2 Lectures 2 Practicals	Written examination 90 minutes
	Subject: * MGnew *** **				
GAMES-DGS-M	Designing Gamified Systems	every summer semester(2025)	6	4	Coursework Assignment and Colloquium
GAMES-META-M	Understanding and Designing the Metaverse (Research Project)	every winter semester(2025)	6	0	Coursework Assignment and Colloquium
	Subject: Information Systems Management				

ISM-DSI-M	Global Collaboration and Digital Social Innovation	every winter semester(1)	6	0	Coursework Assignment with presentation (Global Collaboration and Digital Social Innovation)
	Subject: Information Systems and Services				
ISDL-ISS2-M	Optimization of IT-Reliant Processes	every summer semester	6	2 Lectures 2 Practicals	Written examination 90 minutes
	Subject: Platform economics				
ISPL-DIGB-B	Digital Business	every winter semester	6	4	Written examination 90 minutes
ISPL-DPIS-M	Digital Platforms in Industries and Society	every winter semester(1)	6	4	Written examination 90 minutes
ISPL-FIISM-B	Fundamentals of International IS Management	every summer semester(1)	6	4	Written examination 90 minutes
ISPL-MASI-B	Supplier relationships and mergers & acquisitions in the software industry	every winter semester	3	2 Lectures and Practicals	Written examination 90 minutes
ISPL-MDP-M	Managing Digital Platforms	every summer semester(1)	6	4	Written examination 90 minutes
	Subject: Social Networks				
SNA-OSN-M	Project Online Social Networks	every winter semester	6	4 Practicals	Coursework Assignment and Colloquium 4 months 30 minutes

ID	Module	Semester	ECTS	Weekly Contact Hours	Examination
	Course language German, exams in English on demand, course material may be available in English				
	Find all courses taught in German with course material available and exam held in English on demand below. Please notify the lecturer you need the course material/exam in English!				
	Subject Group: Applied Computer Science				
	Subject: Cognitive Systems				
KogSys-KI-B	Introduction to Artificial Intelligence	every summer semester(1)	6	2 Lectures 2 Practicals	105 minutes
	Subject Group: Computer Science				
	Subject: Foundations of Computer Science				
GdI-MTL-B	Modal and Temporal Logic	every winter semester	6	4 Lectures and Practicals	Oral examination
	Subject Group: Information Systems				
	Subject: Digital Health				
ISHANDS-Change-M	Digital Change Management	every summer semester	6	2 Lectures 2 Practicals	Written examination 90 minutes
ISHANDS-Health-M	Digital Health	every summer semester	6	2 Lectures 2 Practicals	Written examination 90 minutes
	Subject: Information Systems Management				
ISM-IOM-M	International Outsourcing Management	every winter semester	6	4	Written examination 90 minutes
	Subject: Information Systems and Services				
ISDL-DEXP-B	Digital Experimentation	every winter semester	6	2 Lectures and Practicals	Written examination 90 minutes
ISDL-ISS3-M	IT Business Value		6	2 Lectures	Written examination

		every summer semester		2 Practicals	90 minutes
	Subject: Social Networks				
SNA-ASN-M	Social Network Analysis	every winter semester	6	2 Lectures 2 Practicals	Written examination 90 minutes
SNA-NET-M	Network Theory	every summer semester	6	2 Lectures 2 Practicals	Written examination 90 minutes
SNA-WIM-B	Knowledge- and Informationmanagement	every summer semester	6	2 Lectures 2 Practicals	Written examination 90 minutes