University of Augsburg

Module Catalogue

Austauschstudium FAI

Faculty of Applied Computer Science

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Index by Module Groups

1) Faculty of Applied Computer Science - Bachelor Level

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2) Faculty of Applied Computer Science - Master Level

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Module GEO-1023: Practical Methods 1 *Praktische Arbeitsmethoden 1*	5 ECTS/LP
Version 3.0.0 (since WS22/23) Person responsible for module: Dr. Cecile Remy	
Contents: The range of exercises includes, among other things, empirical surveys, qualitative methods of human geography, computer-aided data analysis and modelling, measurement methods, field practicals, laboratory analyses, applications of remote sensing, simulations and geodata analysis and visualization with geographic information systems.	
Learning Outcomes / Competences: This module enables students to acquire basic geographical working methods. After attending this module, the students are able to describe a specific working method in geography (depending on the course chosen), to use this method independently in the right context and to evaluate the results and classify their use. The focus here is on learning and practicing the specific method(s).	
Workload: Total: 150 h	
Conditions: Depending on the content of the course, special technical requirements may be necessary. In principle, the contents of all basic modules are recommended. None for exchange students. None for exchange students.	**Credit Requirements:** Pass the module exam

Frequency: each semester	**Recommended Semester:**	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktische Arbeitsmethoden GEO-1023
Mode of Instruction: exercise course
Language: German / English
Contact Hours: 2

Assigned Courses:

Biogeographische Geländeübung (exercise course)

Geographische Datenanalyse und -visualisierung mit R (exercise course)

Globale Wasserspeicher im Klimawandel (exercise course)

Immobilienmarkt- und Immobilienwertermittlung (exercise course)

Innenstadt- und Einzelhandelsentwicklung in Augsburg (exercise course)

Klimaresilienz von Kulturökosystemen in der Praxis (exercise course)

Paläobotanische Geländeübung (exercise course)

Physisch-geographisches Geländepraktikum (exercise course)

Stadtklimamodellierung mit ENVImet (exercise course)

Examination

GEO-1023 Praktische Arbeitsmethoden (5 LP)

practical exam, Protokoll, kurze Hausarbeit, not graded

Description:

protocol, short scientific term

Module GEO-2026: Advanced Module 1 - Human Geography *Aufbaumodul 1 - Humangeographie*		6 ECTS/LP
Version 3.0.0 (since WS22/23) Person responsible for module: MSc. Niklas Völkening		
Contents: Thematic and regional deepening of a human-geographical topics, e.g. global change, humans and the environment in the Anthropocene, environmental geography, renewable energies, natural resource management, rural areas, geography of foods, geographic development research.		
Learning Outcomes / Competences: The students can explain in-depth knowledge on a specific topic of human geography and present the current state of research. The students can analyse, assess and critically assess the most important principles, theories and methods on the respective topic. In addition, the students can set up theses on selected topics and propose possible solutions. The students can organize and moderate a scientific discussion and develop and defend their own arguments.		
Workload: Total: 180 h		
Conditions: none		**Credit Requirements:** Pass the module exam
Frequency: each semester	**Recommended Semester:**	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Spezialvorlesung Humangeographie GEO-2026
Language: German / English
Contact Hours: 2
ECTS Credits: 3.0

Assigned Courses:

Spezialvorlesung Geographie des ländlichen Raumes (lecture)

Spezialvorlesung Klimaresilienz von Kulturökosystemen (lecture)

Spezialvorlesung: Environment and Society in the American West (lecture)

Part of the Module: Begleitseminar zur Spezialvorlesung Humangeographie GEO-2026
Language: German / English
Contact Hours: 2
ECTS Credits: 3.0

Assigned Courses:

Begleitseminar 1 Geographie des ländlichen Raums (seminar)

Begleitseminar 1: Environment and Society in the American West (seminar)

Begleitseminar 2 Geographie des ländlichen Raums (seminar)

Begleitseminar 2: Environment and Society in the American West (seminar)

Begleitseminar Klimaresilienz von Kulturökosystemen (seminar)

Examination

Aufbaumodul 1 - Humangeographie

lecture + accompanying seminar, mündl. Prüfung (15 Min.) oder Klausur oder Portfolioprüfung

Description:

Module exam, Oral exam 15 minutes, written exam or portfolio

Module GEO-2027: Advanced Module 1 - Physical Geography *Aufbaumodul 1 - Physische Geographie*	6 ECTS/LP
Version 3.0.0 (since WS22/23) Person responsible for module: Dr. Cecile Remy	
Contents: Thematic and regional deepening of a physical-geographical topic, e.g. global change, environmental protection, urban ecology, landscape balance, vegetation history, biochemical cycles, extreme events; Africa, India, Mediterranean Basin, Alps.	
Learning Outcomes / Competences: The students can explain in-depth knowledge on a specific topic of physical geography and present the current state of research. The students can analyse, assess and critically assess the most important principles, theories and methods on the respective topic. In addition, the students can set up theses on selected topics and propose possible solutions. The students can organize and moderate a scientific discussion and develop and defend their own arguments.	
Workload: Total: 180 h	
Conditions: none	**Credit Requirements:** Pass the module exam

Frequency: each semester	**Recommended Semester:**	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Spezialvorlesung Physische Geographie GEO-2027
Mode of Instruction: lecture
Language: German / English
Contact Hours: 2

Assigned Courses:

Spezialvorlesung Biosphäre im Klimasystem / Biosphere in the Climate system (lecture)

Spezialvorlesung Klimaresilienz von Kulturökosystemen (lecture)

Part of the Module: Begleitseminar zur Spezialvorlesung Physische Geographie GEO-2027
Mode of Instruction: seminar
Language: German / English
Frequency: annually
Contact Hours: 2

Assigned Courses:

Begleitseminar Biosphäre im Klimasystem / Biosphere in the Climate system (seminar)

Begleitseminar Klimaresilienz von Kulturökosystemen (seminar)

Examination
Aufbaumodul 1 - Physische Geographie
module exam, mündl. Prüfung (15 Min.) oder Klausur oder Portfolioprüfung
Description:
Oral exam (15 min.) or written exam

Module GEO-2065: Practical Methods 2 *Praktische Arbeitsmethoden 2*	5 ECTS/LP
Version 3.0.0 (since WS22/23) Person responsible for module: Dr. Cecile Remy	
Contents: The range of exercises includes, among other things, empirical surveys, qualitative methods of human geography, computer-aided data analysis and modelling, measurement methods, field practicals, laboratory analyses, applications of remote sensing, simulations and geodata analysis and visualization with geographic information systems.	
Learning Outcomes / Competences: This module enables students to acquire basic geographical working methods. After attending this module, the students are able to describe a specific working method in geography (depending on the course chosen), to use this method independently in the right context and to evaluate the results and classify their use. The focus here is on learning and practicing the specific method(s).	
Workload: Total: 150 h	
Conditions: Depending on the content of the course, special technical requirements may be necessary. In principle, the contents of all basic modules are recommended.	**Credit Requirements:** Pass the module exam

Frequency: each semester	**Recommended Semester:** 3. - 6.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktische Arbeitsmethoden GEO-2065
Mode of Instruction: exercise course
Language: German / English
Contact Hours: 2

Assigned Courses:

Biogeographische Geländeübung (exercise course)

Geographische Datenanalyse und -visualisierung mit R (exercise course)

Globale Wasserspeicher im Klimawandel (exercise course)

Immobilienmarkt- und Immobilienwertermittlung (exercise course)

Innenstadt- und Einzelhandelsentwicklung in Augsburg (exercise course)

Klimaresilienz von Kulturökosystemen in der Praxis (exercise course)

Paläobotanische Geländeübung (exercise course)

Physisch-geographisches Geländepraktikum (exercise course)

Stadtklimamodellierung mit ENVImet (exercise course)

Examination
GEO-2065 Praktische Arbeitsmethoden 2
practical exam, Protokoll, kurze Hausarbeit, not graded

Module GEO-2073: Special Methods in Physiscal Geography *Spezielle Methoden der Physischen Geographie*	5 ECTS/LP
Version 2.0.0 (since WS22/23) Person responsible for module: Prof Dr. Christoph Beck	
Contents: Basics, application and interpretation of results of specific qualitative and quantitative investigation methods from the various sub-areas of physical geography. Field methods: e.g. soil assessment, runoff measurement, site climate recording, vegetation mapping. Laboratory methods: e.g. determination of soil type, analysis of water components, pollen analysis. IT-supported data analysis and modelling: e.g. runoff modelling, numerical climate modelling, statistical analysis of geoscientific data sets.	
Learning Outcomes / Competences: After attending this module, the students know important methods of investigation in physical geography and can explain the specific procedures. They are able to select and apply appropriate methods in relation to the problem and to interpret the corresponding analysis results.	
Remarks: -	
Workload: Total: 150 h 60 h studying of course content using provided materials (self-study) 60 h (self-study) 30 h (attendance)	

Conditions: none for exchange students		**Credit Requirements:** Pass the module exam
Frequency: each winter semester	**Recommended Semester:** 3. - 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Vorlesung Spezielle Methoden der Physischen Geographie

Mode of Instruction: lecture
Language: German / English
Contact Hours: 2
ECTS Credits: 5.0

Examination

Spezielle Methoden der Physischen Geographie

written exam, kurze Hausarbeit oder praktische Prüfung oder Kurzprotokoll oder Portfolioprüfung (s. Veranstaltung) / length of examination: 90 minutes

Test Frequency:

only in the winter semester

Description:

short scientific term paper, practical exercise or short report

Module GEO-3082: Advanced Module 2 - Human Geography *Aufbaumodul 2 - Humangeographie*		6 ECTS/LP
Version 3.0.0 (since WS22/23) Person responsible for module: MSc. Niklas Völkening		
Contents: Thematic and regional deepening of a human-geographical topic, e.g. global change, humans and the environment in the Anthropocene, environmental geography, renewable energies, natural resource management, rural areas, geography of foods, geographic development research.		
Learning Outcomes / Competences: The students can explain in-depth knowledge on a specific topic of human geography and present the current state of research. The students can analyse, assess and critically assess the most important principles, theories and methods on the respective topic. In addition, the students can set up theses on selected topics and propose possible solutions. The students can organize and moderate a scientific discussion and develop and defend their own arguments.		
Workload: Total: 180 h		
Conditions: none		**Credit Requirements:** Pass the module exam
Frequency: each semester	**Recommended Semester:** 5. - 8.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Spezialvorlesung Humangeographie GEO-3082
Mode of Instruction: lecture
Language: German / English
Contact Hours: 2
ECTS Credits: 3.0

Assigned Courses:

Spezialvorlesung Geographie des ländlichen Raumes (lecture)

Spezialvorlesung Klimaresilienz von Kulturökosystemen (lecture)

Spezialvorlesung: Environment and Society in the American West (lecture)

Part of the Module: Begleitseminar zur Spezialvorlesung Humangeographie GEO-3082
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 3.0

Assigned Courses:

Begleitseminar 1 Geographie des ländlichen Raums (seminar)

Begleitseminar 1: Environment and Society in the American West (seminar)

Begleitseminar 2 Geographie des ländlichen Raums (seminar)

Begleitseminar 2: Environment and Society in the American West (seminar)

Begleitseminar Klimaresilienz von Kulturökosystemen (seminar)

Examination

Aufbaumodul 2 - Humangeographie

lecture + accompanying seminar, mündliche Prüfung (15 Min.), Klausur oder Portfolio

Description:

Module exam, Oral exam 15 minutes, written exam or portfolio

Module GEO-3083: Advanced Module 2 - Physical Geography *Aufbaumodul 2 - Physische Geographie*	6 ECTS/LP
Version 3.0.0 (since WS22/23) Person responsible for module: Dr. Cecile Remy	
Contents: Thematic and regional deepening of a physical-geographical topic, e.g. global change, environmental protection, urban ecology, landscape balance, vegetation history, biochemical cycles, extreme events; Africa, India, Mediterranean Basin, Alps.	
Learning Outcomes / Competences: The students can explain in-depth knowledge on a specific topic of physical geography and present the current state of research. The students can analyse, assess and critically assess the most important principles, theories and methods on the respective topic. In addition, the students can set up theses on selected topics and propose possible solutions. The students can organize and moderate a scientific discussion and develop and defend their own arguments.	
Workload: Total: 180 h	
Conditions: none	**Credit Requirements:** Pass the module exam

Frequency: each semester	**Recommended Semester:** 5. - 8.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Spezialvorlesung Physische Geographie GEO-3083
Mode of Instruction: lecture
Language: German / English
Contact Hours: 2

Assigned Courses:

Spezialvorlesung Biosphäre im Klimasystem / Biosphere in the Climate system (lecture)

Spezialvorlesung Klimaresilienz von Kulturökosystemen (lecture)

Part of the Module: Begleitseminar zur Spezialvorlesung Physische Geographie GEO-3083
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Assigned Courses:

Begleitseminar Biosphäre im Klimasystem / Biosphere in the Climate system (seminar)

Begleitseminar Klimaresilienz von Kulturökosystemen (seminar)

Examination
Aufbaumodul 2 - Physische Geographie
module exam, mündl. Prüfung (15 Min.) oder Klausur oder Portfolioprüfung
Description:
Oral exam (15 min.) or written exam

Module GEO-3098: Advanced Seminar *Hauptseminar*		5 ECTS/LP
Version 2.1.0 (since WS22/23) Person responsible for module: MSC. Robert Gonda		
Contents: In this module, content from the basic courses is deepened and new developments in the subject of geography are dealt with. Advanced seminars are offered on sub-areas of geography, regional focal points and/or special subject areas of geography (such as global change, cultural landscapes, etc.).		
Learning Outcomes / Competences: After completing this module, the students are able to present an in-depth topic of geography in the form of a written work and an oral presentation. For this purpose, the relevant specialist content from the scientific literature is summarized, combined and critically examined. In addition, the moderation and discussion skills of the students are further developed.		
Workload: Total: 150 h 100 h preparation of written term papers (self-study) 20 h preparation of presentations (self-study) 30 h (attendance)		
Conditions: Basic knowledge of scientific work is required. Confident handling of English specialist literature is expected.		**Credit Requirements:** Pass the module exam
Frequency: each semester	**Recommended Semester:** 5. - 8.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module
Part of the Module: Hauptseminar **Mode of Instruction:** advanced seminar **Language:** German / English **Contact Hours:** 2 **ECTS Credits:** 5.0
Assigned Courses: **Climate Urbanism** (advanced seminar) **Climate-Induced Migration, Immobility and Water Controversies** (advanced seminar) **Geographische Stadtforschung** (advanced seminar) **Kryosphäre im Klimasystem** (advanced seminar) **Kulturgeographie** (advanced seminar) **Planetare Grenzen** (advanced seminar) **Sozialökologische Transformation und multiple Krisen** (advanced seminar)

Examination

Hauptseminar

/ work period for assignment: 6 weeks

Test Frequency:

each semester

Description:

Das in der Hausarbeit erarbeitete Thema wird im Hauptseminar präsentiert.

Module INF-0029: Research Module Software Methodologies for Distributed Systems

Forschungsmodul Softwaremethodiken für verteilte Systeme

6 ECTS/LP

Version 1.0.0 (since SoSe13)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After participating in the research module, students can understand problems of medium complexity in the field of software methodologies for distributed systems. They have detailed and up-to-date knowledge in the mentioned field and can actively participate in research projects. To this end, they understand advanced concepts, methods, procedures, techniques, and technologies and can contribute this knowledge to research projects. In addition, students have the teamwork and communication skills, the ability to study literature, and the learning and working techniques to discuss problems in the field and critically evaluate, combine, and present interim results.

Key qualifications: Ability to think logically, analytically, and conceptually; independent work with literature; comprehensible, confident, and convincing presentation of ideas, concepts, and results; quality awareness; communication skills; ability to work in teams and understand team processes; principles of good scientific practice;

Workload:
Total: 180 h
15 h seminar (attendance)
165 h internship / practical course (self-study)

Conditions:
none

Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Forschungsmodul Softwaremethodiken für verteilte Systeme
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Current research topics at the DS-Lab.

Literature:
Provided for the respective topics.

Assigned Courses:

Oberseminar zu Softwaremethodik für verteilte Systeme

Examination
Presentation and written paper
internship
Test Frequency:
when a course is offered

Module INF-0048: Research Module Theoretical Computer Science *Forschungsmodul Theoretische Informatik*	6 ECTS/LP

Version 1.0.0 (since SoSe13)
Person responsible for module: Prof. Dr. Torben Hagerup

Learning Outcomes / Competences:
After successful participation in the research module, the students will be in a position to understand problems of intermediate complexity in the field of Theoretical Computer Science. Furthermore, they will have detailed and up-to-date knowledge in the field, enabling them to actively develop and apply its concepts, methods, processes, and techniques for their research projects. The students will have team spirit and the ability to communicate, conduct literature research, and evaluate solutions and results in a critical manner.

Key Qualifications:
Logical, analytical, and conceptual comprehension; independent work with English technical literature; capability to present thoughts, concepts, and conclusions in an understandable, confident, and convincing way; quality awareness; communication skills; knowledge of fundamentals of good scientific practice.

Workload:
Total: 180 h
165 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions:
none

Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Research Module Theoretical Computer Science
Mode of Instruction: internship
Language: German
Contact Hours: 1

Contents:
Collaboration on current research topics of the group.

Literature:
- Scientific papers, manuals.

Assigned Courses:

Oberseminar Theoretische Informatik

Examination
Oral presentation and written paper.
internship

Module INF-0064: Research Module Organic Computing *Forschungsmodul Organic Computing*		6 ECTS/LP
Version 1.0.0 (since SoSe14) Person responsible for module: Prof. Dr. Jörg Hähner		
Learning Outcomes / Competences: After participating in the research module, students are able to understand problems of medium complexity in the field of "Organic Computing". They have detailed and up-to-date knowledge in the mentioned field and can actively participate in research projects. To this end, they understand advanced concepts, methods, procedures, techniques and technologies and can contribute this knowledge to research projects. In addition, students have the teamwork and communication skills, the ability to research literature and the learning and working techniques to discuss problems in the field, as well as to critically evaluate, combine and present interim results. **Key qualifications:** Ability to think logically, analytically and conceptually; independent work with specialist literature in English; comprehensible, confident and convincing presentation of ideas, concepts and results; quality awareness; communication skills; ability to work in teams and understand team processes; principles of good scientific practice.		
Workload: Total: 180 h 165 h internship / practical course (self-study) 15 h seminar (attendance)		
Conditions: none		
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Research Module Organic Computing
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Collaboration on current research topics.

Literature:
Depending on the topic to be worked on:
- Paper
- Book
- Handbook

Assigned Courses:

Oberseminar Organic Computing

Examination
Presentation and final report.
internship

Module INF-0075: Research Module Databases and Information Systems *Forschungsmodul Datenbanken und Informationssysteme*	6 ECTS/LP

Version 1.2.0 (since SoSe14)
Person responsible for module: Prof. Dr. Peter Michael Fischer

Learning Outcomes / Competences:
After participating in the research module, students can understand medium-complexity problems in the field of databases and information systems. They have detailed and up-to-date knowledge in the aforementioned field and can actively participate in research projects. To this end, they understand advanced concepts, methods, procedures, techniques, and technologies out of this field and can apply this knowledge to research projects. In addition, students have skills in teamworking and communication, the ability to study research literature and the methods to discuss problems in the field, as well as to critically evaluate, combine and present intermediate results.
Key Skills: Logical, analytical, and conceptual thinking; Independent work with English-language literature; Intelligible, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Working in teams and understanding team processes; Principles of good scientific practice.

Workload:
Total: 180 h
15 h seminar (attendance)
165 h internship / practical course (self-study)

Conditions:
Module Database Systems (INF-0073) - recommended

Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Forschungsmodul Datenbanken und Informationssysteme
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Current research topics in the field of database systems and Big Data

Literature:
- Current research articles with relation to "Big Data"
- Manuals of the relevant products and frameworks

Assigned Courses:

Forschungsmodul Datenbanken und Informationssysteme (internship)

Oberseminar Datenbanken und Informationssysteme

Examination
Software acceptance, presentation, final report
internship

Module INF-0089: Seminar Multimedia Computing & Computer Vision (BA) *Seminar Multimediale Datenverarbeitung*	4 ECTS/LP

Version 1.0.0 (since SoSe14)
Person responsible for module: Prof. Dr. Rainer Lienhart

Learning Outcomes / Competences:
After attending the seminar, the students can independently work out and analyse advanced problems, concepts, methods, procedures, techniques, and technologies from the field of multimedia computing and computer vision (e.g. image and video processing, machine learning, and image and video search) and evaluate them in relation to the individual seminar topic.
Participants possess scientific methodology, communication skills, and the ability to present a special topic clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively.
Furthermore, they learn to recognise logical structures of thinking and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a talk that is clear and easy to follow. Additionally, the students know how to focus on essential messages and convey them in a comprehensible way, even with complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to confidently deal with common presentation media and use them interactively. They manage to gear a talk to a specific target group, apply various moderation techniques, and keep their audience engaged even over a longer period.
Key qualifications: Presentation techniques; literature research; principles of good scientific practice; evaluating solution approaches, procedures, techniques, and technologies from different points of view.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 3.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Multimediale Datenverarbeitung
Mode of Instruction: seminar
Language: German
Frequency: each winter semester
Contact Hours: 2

Contents:
The topics of the seminar from the wide-ranging field of multimedia and machine vision are determined each year and adapted to current trends.

Literature:
Current research literature

Assigned Courses:

Seminar über Multimediale Datenverarbeitung (Bachelor) (seminar)

Examination

Presentation and written paper

seminar

Test Frequency:

when a course is offered

Module INF-0090: Research Module Multimedia Computing & Computer Vision (BA) *Forschungsmodul Multimedia Computing & Computer Vision*	6 ECTS/LP

Version 1.0.0 (since SoSe14)
Person responsible for module: Prof. Dr. Rainer Lienhart

Learning Outcomes / Competences:
After participating in the research module, students can understand problems of medium complexity in the field of multimedia (image, video, and audio processing with machine learning). They have detailed and up-to-date knowledge in the aforementioned field and can actively participate in research projects. To this end, they understand advanced concepts, methods, procedures, techniques and technologies and can apply this knowledge in research projects.
In addition, students have teamwork and communication skills, the ability to research literature, and techniques to discuss problems in the field, as well as to critically evaluate, combine, and present interim results.
Key qualifications: Ability to think logically, analytically and conceptually; independent work with specialist literature; comprehensible, confident and convincing presentation of ideas, concepts and results; quality awareness; communication skills; ability to work in teams and understand team processes; principles of good scientific practice.

Workload:
Total: 180 h
15 h seminar (attendance)
165 h internship / practical course (self-study)

Conditions:
none

Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Research Module Multimedia Computing & Computer Vision
Mode of Instruction: internship
Language: German
Frequency: as needed
Contact Hours: 1

Contents:
The specific task from the wide-ranging field of multimedia and machine vision (image, video and audio processing, object recognition, search of image, video and audio material) is designed individually for each student every year.

Literature:
scientific papers, manuals

Assigned Courses:

Oberseminar Multimedia Computing

Examination
Presentation and written paper
internship

Module INF-0105: Research Module Teaching Professorship Informatics *Forschungsmodul Lehrprofessur für Informatik*	6 ECTS/LP

Version 1.0.0 (since SoSe14)
Person responsible for module: Prof. Dr. Robert Lorenz

Learning Outcomes / Competences:
After participating in the research module, students can understand problems of medium complexity in the fields of *concurrent systems*, *petri nets* or *process mining*. They have detailed and up-to-date knowledge in the aforementioned field and can actively participate in research projects. To this end, they understand advanced concepts, methods, procedures, techniques and technologies and can apply this knowledge in research projects. In addition, students have teamwork and communication skills, the ability to research literature, and techniques to discuss problems in the field, as well as to critically evaluate, combine, and present interim results.

Key qualifications: Ability to think logically, analytically and conceptually; independent work with specialist literature; comprehensible, confident and convincing presentation of ideas, concepts and results; quality awareness; communication skills; ability to work in teams and understand team processes; principles of good scientific practice.

Workload:
Total: 180 h
165 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions:
Basic knowledge in research topics *concurrent systems*, *petri nets* or *process mining*

Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Research Module Teaching Professorship Informatics
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Collaboration on current research topics in the field of *concurrent systems*, *petri nets* or *process mining.*

Literature:
- J. Desel, W. Reisig, G. Rozenberg: Lectures on Concurrency and Petri Nets, Springer, Lecture Notes in Computer Science 3098, 2004
- Wil M. P. van der Aalst: Process Mining. Data Sciemce in Action. Springer, 2016.

Assigned Courses:

Oberseminar zu Lehrprofessur für Informatik

Examination
Research Module Teaching Professorship Informatics
practical exam

Module INF-0124: Seminar Robotics *Seminar Robotik*	4 ECTS/LP
Version 1.1.0 (since SoSe14) Person responsible for module: Prof. Dr. Wolfgang Reif	

Learning Outcomes / Competences:

After successful completion of the seminar, the students are able to understand and solve basic problems, concepts, methods, procedures, techniques and technologies in the field of robotics.

They will have the working techniques, communication skills and ability to use appropriate media in order to present a special topic clearly and comprehensibly and to critically and argumentatively discuss topics from the aforementioned field. Furthermore they are able to recognise the logical structures of thinking and arguing and use them in a goal-oriented manner.

Participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture in a clear and comprehensible way and to focus on the convey these in an understandable way.

The students understand how to present themselves and how to deal confidently with current presentation media. They manage to gear a lecture to a specific target group and to motivate the listener.

Soft-skills:

- Literature research
- Independently work with technical literature, including English-language literature.
- Analytical competence
- Working methodical
- Principles of good scientific practice
- Ability to present (in writing and orally) ideas,concepts and results (practical or theoretical) and to document them
- Ability to think logically, abstractly, analytically and conceptually, and to argue precisely
- Awareness for quality aspects
- Communication skills
- Time management

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		
Frequency: each summer semester	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Robotik
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:

The concrete topics of the seminar deal with the use and programming of robots of all kinds and are determined annually and adapted to current developments.

Literature:

Depends on the concrete topics of the seminar.

Assigned Courses:

Seminar zu Robotik (seminar)

Examination

Seminar Robotik

written/oral exam / length of examination: 45 minutes

work period for assignment: 3 months

Test Frequency:

when a course is offered

Module INF-0125: Seminar Internet Security *Seminar Internetsicherheit*	4 ECTS/LP
Version 2.0.0 (since SoSe17) Person responsible for module: Prof. Dr. Wolfgang Reif	

Learning Outcomes / Competences:

After completion of the seminar, students are able to understand basic problems, concepts, methods, procedures, techniques and technologies in the field of Internet security and independently learn new such concepts.

They have the working techniques, communication skills and ability to use appropriate media to present this field clearly and comprehensibly in speech and writing and to discuss topics from the mentioned field critically. They will also be able to recognize the logical structures of reasoning and argumentation and use them.

The participants are able to formulate clearly and understandably and to present specialist knowledge freely. They understand how to structure a presentation in a clear and comprehensible way and how to focus the presentation on the core messages and convey them in a comprehensible way.

The students understand how to present themselves and how to work with common presentation media. They manage to focus a presentation to a specific target group and to motivate the audience.

Soft Skills:

- Literature research
- Independently work with English technical literature
- Analytical competence
- Working methodical
- Principles of good scientific practice
- Ability to present (written and oral) ideas, concepts and results in a comprehensible and convincing manner and to document them
- Ability to think logically, abstractly, analytically and conceptually and to argue precisely
- Awareness for quality aspects
- Communication skills
- Time management

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		
Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Internet Security
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:

The specific topics of the seminar deal with the security of computer systems on the Internet and they change from year to year to adapt to current developments.

Literature:

Depends on the concrete topic.

Assigned Courses:

Seminar zu Internetsicherheit (seminar)

Examination

Seminar Internet Security

written/oral exam / length of examination: 45 minutes

work period for assignment: 3 months

Test Frequency:

when a course is offered

Module INF-0126: Seminar Software- and Systems Engineering (Bachelor) *Seminar Software- und Systems Engineering (Bachelor)*	4 ECTS/LP

Version 1.1.0 (since SoSe14)
Person responsible for module: Prof. Dr. Wolfgang Reif

Learning Outcomes / Competences:
After successful completion of the seminar, students are able to understand basic problems, concepts, methods, procedures, techniques and technologies in the field of software and systems engineering and independently learn new such concepts.

They have the working techniques, communication skills and the ability to use appropriate media to present a specific topic clearly and comprehensibly in speech and writing and to discuss topics from the aforementioned field critically. They will also be able to recognize the logical structures of reasoning and argumentation and use them.

The participants are able to formulate clearly and understandably and to present specialist knowledge freely. They understand how to structure a presentation in a clear and comprehensible way and how to focus the presentation on the core messages and convey them in a comprehensible way.

The students understand how to present themselves and how to deal confidently with common presentation media. They manage to focus a presentation to a specific target group and to motivate the audience.

Soft Skills:

- Literature research
- Independently work with English technical literature
- Analytical competence
- Working methodical
- Principles of good scientific practice
- Ability to present (written and oral) ideas, concepts and results in a comprehensible and convincing manner and to document them
- Ability to think logically, abstractly, analytically and conceptually and to argue precisely
- Awareness for quality aspects
- Communication skills
- Time management

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: each winter semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Software- und Systems Engineering (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:

The topics of the seminar deal wtih current trends in Software and Systems Engineering on the level of undergraduate students. The topics change from year to year and are regulary adapted to reflect new developments.

Literature:

Depends on the concrete topic.

Examination

Seminar Software- und Systems Engineering (Bachelor)

written/oral exam / length of examination: 45 minutes

work period for assignment: 3 months

Test Frequency:

when a course is offered

Module INF-0127: Research Module Software- and Systems Engineering *Forschungsmodul Software- und Systems Engineering*		6 ECTS/LP
Version 1.1.0 (since SoSe14) Person responsible for module: Prof. Dr. Wolfgang Reif		
Learning Outcomes / Competences: After participating in the research module, students are able to understand problems of medium complexity from the field of software and systems engineering. They have detailed and up-to-date knowledge in the aforementioned field and can actively participate in research projects. They understand advanced concepts, methods, procedures, techniques and technologies and can apply this knowledge in research projects. In addition, students have teamwork and communication skills, the ability to do literature research and the learning and working techniques to discuss problems in the field, as well as to critically evaluate, combine and present intermediate results. **Soft Skills**: • Skill in logical, analytical and conceptual thinking. • Ability to work independently with technical literature, including English literature • Clear, confident and convincing presentation of ideas, concepts and results • Awareness for quality aspects • Communication skills • Ability to work in teams and understand team processes • Principles of good scientific practice		
Workload: Total: 180 h 165 h internship / practical course (self-study) 15 h seminar (attendance)		
Conditions: none		
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module
Part of the Module: Research Module Software- and Systems Engineering **Mode of Instruction:** internship **Language:** German / English **Contact Hours:** 1
Contents: Contribution to current research projects of the chair for Software Engineering
Literature: Depends on the project: Scientific papers, system documentation, books, ...
Assigned Courses: **Oberseminar Software- und Systems Engineering**

Examination

Research Module Software- and Systems Engineering Project Presentation

practical exam / work period for assignment: 6 weeks

Test Frequency:

when a course is offered

Module INF-0173: Research Module Human-Centered Multimedia *Forschungsmodul Human-Centered Multimedia*	6 ECTS/LP
Version 1.0.0 (since SoSe13) Person responsible for module: Prof. Dr. Elisabeth André	

Learning Outcomes / Competences:
After participating in the research module, students are able to understand problems of medium complexity in the field of "Human-Centered Multimedia". They have detailed and up-to-date knowledge in the aforementioned field and can actively participate in research projects. To this end, they understand advanced concepts, methods, procedures, techniques and technologies and can apply this knowledge in research projects. In addition, students have the teamwork and communication skills, the ability to research literature and the learning and working techniques to discuss problems in the field, as well as to critically evaluate, combine and present intermediate results.

Key qualifications: Skill in logical, analytical, and conceptual thinking; Independent work with English-language literature; Understandable, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill in working in teams and understanding team processes; Principles of good scientific practice;

Workload:
Total: 180 h
165 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Research Module Human-Centered Multimedia
Mode of Instruction: internship
Language: German
Contact Hours: 1

Contents:
Collaborate on current research topics in the area of Human-Centered Multimedia.

Literature:
Literature references will be given at the beginning of the module depending on the topic.

Assigned Courses:

Oberseminar Human-Centered Multimedia

Examination
Research Module Human-Centered Multimedia
practical exam

Module INF-0188: Seminar Algorithms and Data Structures for Bachelors *Seminar Algorithmen und Datenstrukturen für Bachelor*	4 ECTS/LP
Version 1.0.0 (since WS15/16) Person responsible for module: Prof. Dr. Torben Hagerup	
Learning Outcomes / Competences: Upon completion of the seminar, the students will be able to independently acquire algorithm-related contents from less demanding original scientific texts and to present them clearly and understandably, in spoken and written form. They will understand how to condense a text to its essentials and to structure a presentation within a given time frame. **Key Qualifications:** Capability of logical, analytical, and conceptual comprehension and of participating in concise debates on technical topics; literature research; self-contained work with English technical literature; quality awareness; meticulousness; communication skills; time management.	
Workload: Total: 120 h 30 h seminar (attendance) 90 h preparation of written term papers (self-study)	
Conditions: Familiarity with basic algorithms and data structures (as imparted, e.g., by the course "Informatik III") will be highly useful.	

Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Algorithms and Data Structures

Mode of Instruction: seminar

Language: German

Contact Hours: 2

Contents:

Current and classical topics from the field of Algorithms and Data Structures are studied, using original literature.

Literature:

Selected scientific articles.

Examination

Written paper and oral presentation.

seminar

Module INF-0226: Seminar Database Systems Bachelor *Seminar Datenbanksysteme für Bachelor*	4 ECTS/LP
Version 1.0.0 (since SoSe16) Person responsible for module: Prof. Dr. Peter Michael Fischer	

Learning Outcomes / Competences:
After attending the seminar, students are able to independently work out and understand basic problems, concepts, methods, procedures, techniques and technologies in the field of database systems.
They have the working techniques, communication skills and ability to use appropriate media to present a special topic clearly and comprehensibly, both verbally and in writing, and to discuss topics from the aforementioned field critically and argumentatively. They will also be able to recognize and use logical structures of reasoning and argumentation in a goal-oriented manner.
The participants are able to formulate clearly and understandably and to present specialist content freely. They understand how to structure a lecture in a clear and comprehensible way and how to focus the lecture on essential messages and convey them in a comprehensible way.
The students understand how to present themselves and how to deal confidently with common presentation media. They manage to gear a lecture to a specific target group and to motivate the listener and to apply various moderation techniques.
Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and for their documentation; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: Module Database Systems (INF-0073) - recommended		
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Datenbanksysteme für Bachelor
Mode of Instruction: seminar
Language: German / English
Frequency: irregular (usu. summer semester)
Contact Hours: 2

Contents:
Current research contributions from the field of "Databases and Information Systems".

Literature:
Current research contributions

Assigned Courses:

Seminar Datenbanksysteme für Bachelor (seminar)

Examination

Presentation and written elaboration

seminar

Module INF-0261: Practical Module on Manufacturing Technology *Praktikum Produktionstechnik*		5 ECTS/LP
Version 1.1.0 (since WS17/18) Person responsible for module: Prof. Dr.-Ing. Johannes Schilp		
Learning Outcomes / Competences: Students will be able to apply basic knowledge of production engineering and technical order processing in practice. They transfer theoretical methods and models from the lecture Production Engineering to practice-oriented tasks. They are able to successfully solve and present project tasks in small groups. Key qualifications: Teamwork and communication skills, structured and conscientious work, application-oriented problem solving, evaluation of results and weighing of solution approaches, ability to think logically, analytically and conceptually.		
Remarks: It is not possible to take INF-0261 if the module INF-0242 has already been taken!		
Workload: Total: 150 h 90 h studying of course content through exercises / case studies (self-study) 60 h internship / practical course (attendance)		
Conditions: Recommendation: First experience with Catia V5 (preliminary course). It is recommended that you have previously taken one of the following modules: INF-0196: Production Informatics INF-0197: Process modeling and production control INF-0260: Production Engineering		
Frequency: each summer semester	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module on Manufacturing Technology
Mode of Instruction: internship
Language: German
Contact Hours: 4

Contents:

In the internship, project tasks/experiments/learning games are offered on each of the following main topics:

- Production organization
- Automation technology
- Production planning and control
- Quality management
- Logistics

Assigned Courses:

Praktikum für Produktionstechnik (internship)

Examination

Praktikum Produktionstechnik

practical exam / length of examination: 45 minutes

Module INF-0267: Practical Module Deep Learning *Praktikum Deep Learning*	5 ECTS/LP

Version 1.1.0 (since WS17/18)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
The students get to know systems for pattern recognition by means of deep learning and acquire basic knowledge of neural machine learning methods. After participating in the practical course, the students understand the functionality and concepts of neural networks, in particular their mathematical foundations, and the concepts of software tools for their implementation, such as Tensorflow.

The participants can evaluate intelligent neural systems in relation to the algorithmic solution and transfer their knowledge and solution approaches to other problems. They are also familiar with methods for quantitatively evaluating the performance of a corresponding system. In addition, fundamental problems of pattern recognition and deep learning can be analyzed and behaviors of deep neural networks can be interpreted.

The students can specify different types of information processing and analysis and implement them algorithmically within the framework of practical programming tasks. You can also critically identify and evaluate misconduct and find solutions to reduce it.

Key qualifications: Implementation of solution concepts using machine learning in software; Ability to analyze and structure IT problems and to develop and implement solution strategies; Knowledge of the advantages/disadvantages of design alternatives, evaluation in the respective application context; skill of teamwork; Ability to understand, document and present results; quality awareness.

Workload:
Total: 150 h
90 h studying of course content through exercises / case studies (self-study)
60 h internship / practical course (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: usu. at least once per acad. year	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Deep Learning
Mode of Instruction: internship
Language: English
Frequency: each semester
Contact Hours: 4

Contents:
On the basis of practical tasks, primarily neural models for information processing are considered. Examples include intelligent processing of audio and video signals. Common current network topologies such as convolutional networks, recurrent networks with memory or generative adversial networks are presented. In the field of deep learning, complex neural networks are treated, whose behavior cannot be easily predicted and which are subject to constant change.

Literature:
Will be announced by the lecturer.

Assigned Courses:

Praktikum Deep Learning (internship)

Praktikum Digital Health (internship)

Examination

Praktikum Deep Learning

practical exam

Module INF-0268: Practical Module Computational Intelligence *Praktikum Computational Intelligence*	5 ECTS/LP
Version 1.5.0 (since WS17/18) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:
The students get to know and be able to use the basic concepts and algorithms of machine learning transfer these to practical problems after participating in the internship. The students understand the functionality and concepts of data-based modelling, including its mathematical foundations, and can apply the knowledge gained using various software tools and libraries. The participants can evaluate intelligent systems with regard to their algorithmic solution and transfer their knowledge and solution approaches to other problems. They are also familiar with methods for quantitatively evaluating the performance of a corresponding system. In addition, fundamental problems of pattern recognition can be analyzed and the behavior of machine learning methods, such as decision trees, support vector machines, or neural networks, can be interpreted. The students can specify different types of information processing and analysis and implement them algorithmically within the framework of practical programming tasks. You can also critically identify and evaluate misconduct and find solutions to reduce it. Key qualifications: Implementation of solution concepts using machine learning in software; Ability to analyze and structure IT problems and to develop and implement solution strategies; Knowledge of the advantages/disadvantages of design alternatives, evaluation in the respective application context; skill of teamwork; Ability to understand, document and present results; quality awareness.

Workload:
Total: 150 h
60 h internship / practical course (attendance)
90 h studying of course content through exercises / case studies (self-study)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Computational Intelligence
Mode of Instruction: internship
Language: English
Frequency: irregular
Contact Hours: 4

Contents:
Introduction to intelligent systems. Symbolic and signal-based features. basis of machine intelligence: linear decision functions, distance classifiers, nearest neighbor rule, Kernel machines, Bayesian classifier, rule-based methods, decision trees, ensemble learning, neural networks, dynamic classification. Classification and Regression. learning method. feature reduction and feature selection. Methods of cluster analysis, semi-supervised learning. evaluation.

Literature:

- I.H. Witten, F. Eibe, M.A. Hall: Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 2011.
- B. Schuller: Intelligent Audio Analysis, Springer, 2013.
- K. Kroschel, G. Rigoll, B. Schuller: Statistische Informationstechnik, 5. Neuauflage, Springer, 2011.

Examination

Praktikum Computational Intelligence

written exam / length of examination: 90 minutes

Module INF-0269: Seminar Embedded Intelligence for Health Care and Wellbeing (Bachelor) *Seminar Embedded Intelligence for Health Care and Wellbeing (Bachelor)*	4 ECTS/LP

Version 1.0.0 (since WS17/18)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
After attending the seminar, the students are able to independently develop and understand basic problems, concepts, methods, procedures, techniques and technologies in the field of e-health and m-health. You have the working techniques, communication skills and ability to use the appropriate media to present a specific topic in spoken and written form in a clear and understandable way and to discuss topics from the area mentioned critically and argumentatively. You can also recognize the logical structures of thinking and arguing and use them effectively.

The participants can formulate clearly and understandably and present specialist content freely. You know how to structure a presentation clearly and to focus the presentation on essential messages and to convey them in an understandable way.

The students know how to be present and how to handle common presentation media confidently. You manage to align a lecture to a specific target group and to motivate the listener and to use various moderation techniques.

Key qualifications: Principles of good scientific practice; Analytical-methodical competence; time management; literature research; Independent work with English-language specialist literature; communication skills; Ability to present practical and theoretical ideas in an understandable, secure and convincing (oral and written) way, writing papers in the LaTeX typesetting language; quality awareness.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Embedded Intelligence for Health Care and Wellbeing (Bachelor)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:

The seminar deals with current relevant topics in the context of embedded intelligence in the health sector. These include u.a. Sensor technologies for knowledge-based monitoring of health-related activities, vital signs and context factors, multi-sensory acquisition, analysis and interpretation of biological parameters (e.g. metabolic, cardiological and neurological signals), but also user modeling and user interfaces for health and fitness applications.

The students work on the given topic based on scientific literature and give a presentation and prepare a written summary.

Literature:

Will be announced by the lecturer

Examination

Seminar Embedded Intelligence for Health Care and Wellbeing (Bachelor)

written/oral exam

Module INF-0271: Research Module Embedded Intelligence for Health Care and Wellbeing *Forschungsmodul Embedded Intelligence for Health Care and Wellbeing*	6 ECTS/LP

Version 1.1.0 (since WS17/18)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
After participating in the research module, students are able to understand problems of medium complexity in the field of intelligent embedded systems, in particular signal analysis for e-health and m-health applications. They have detailed and up-to-date knowledge in the area mentioned and can actively participate in research projects. In addition, they understand advanced concepts, methods, procedures, techniques and technologies and can contribute this knowledge to research projects. In addition, the students have the team and communication skills, the ability to research scientific literature and the learning and working techniques to discuss problems in the field, as well as to critically evaluate, combine and present interim results.

Key Qualifications: Ability to think logically, analytically and conceptually; Independent work with English-language specialist literature; Understandable, safe and convincing presentation of ideas, concepts and results; quality awareness; communication skills; Team collaboration skills and understanding of team processes; principles of good scientific practice; project management skills; Scientific Method.

Workload:
Total: 180 h
165 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each semester	**Recommended Semester:** 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Research Module Embedded Intelligence for Health Care and Wellbeing
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Participation in current research topics.

Literature:
Scientific publications; manuals; is provided by the chair.

Assigned Courses:

Oberseminar Embedded Intelligence for Health Care and Wellbeing

Examination
Presentation and written paper
practical exam

Module INF-0276: Practical Module Automotive Software Engineering (BA) *Praktikum Automotive Software Engineering (BA)*	6 ECTS/LP

Version 1.0.0 (since SoSe18)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After participating in the practical course Automotive Software Engineering, the students understand practical problems of higher complexity in the field of development and validation of driving assistance systems with current methods and tools of model-based development of embedded systems. The students acquire in-depth subject-specific and interdisciplinary knowledge and skills, such as control engineering, driving physics, and mathematics. They are able to develop concepts, methods, procedures, techniques, and technologies of the named area in research projects and are able to apply strategies in solving problems. In addition, students have teamwork and communication skills the ability to research literature to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine, present, and document intermediate results and innovative ideas in an understandable way.

Key qualifications: Ability to think logically, analytically, and conceptually; Independent work with English-language technical literature; Understandable, confident, and convincing presentation of ideas, concepts, and results; Quality awareness; Communication skills; Ability to work in teams and understand team processes; Project management skills.

Workload:
Total: 180 h
90 h studying of course content through exercises / case studies (self-study)
90 h internship / practical course (attendance)

Conditions:
Empfohlen wird die Teilnahme am links aufgeführten Seminar.

Module Seminar Basics of Software Engineering for Automotive Systems (BA) (INF-0027) - recommended

Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Automotive Software Engineering (BA)
Mode of Instruction: internship
Language: German
Frequency: each winter semester
Contact Hours: 6

Contents:
In the automotive practical course, participants learn how various selected functions within vehicles can be simulated and analyzed. The necessary theoretical foundations are laid for working on the experimental task in a two-day introductory course. The anti-lock braking system (ABS) model is treated on control units during the initial period. Among other things, the participants will get to know the modeling tool combination "Matlab/Simulink", which is frequently used in the automotive environment, and the graphical simulation and analysis tool "CarMaker" and gain a practical insight into the functioning of FlexRay bus systems.
After the introductory course, the model of an ACC (Adaptive Cruise Control) system will be created, simulated, and verified in groups of two to three participants.

Literature:

depending on the subject

Examination

Practical Module Automotive Software Engineering (BA)

oral exam / length of examination: 30 minutes

Test Frequency:

when a course is offered

Module INF-0313: Seminar IT Infrastructure in Medical Information Systems for Bachelor Students *Seminar IT-Infrastrukturen in der Medizin für Bachelor*	4 ECTS/LP

Version 1.0.0 (since SoSe19)
Person responsible for module: Prof. Dr. Frank Kramer

Learning Outcomes / Competences:
After attending the seminar, students are able to independently work out and understand basic problems, concepts, methods, procedures, techniques and technologies in the field of IT infrastructures for translational medical research. They have the working techniques, communication skills and ability to use appropriate media to present a specific topic clearly and comprehensibly, both verbally and in writing, and to discuss topics from the aforementioned field critically and argumentatively. They will also be able to recognize and use logical structures of reasoning and argumentation in a goal-oriented manner. The participants are able to formulate clearly and understandably and to present specialist content freely. They understand how to structure a lecture in a clear and comprehensible way and how to focus the lecture on essential messages and convey them in a comprehensible way. The students understand how to present themselves and how to deal confidently with common presentation media. They manage to gear a lecture to a specific target group and to motivate the listener and to apply various moderation techniques.
Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and in documenting them; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		**Credit Requirements:** Passing the module examination
Frequency: each semester	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar IT Infrastructure in Medical Information Systems for Bachelor Students
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
Current topics of IT infrastructures in medicine

Literature:
will be presented in the respective kickoff event.

Examination
Seminar IT Infrastructure in Medical Information Systems for Bachelor Students
written/oral exam

Module INF-0321: Practical Module Speech Pathology *Praktikum Speech Pathology*	5 ECTS/LP
Version 1.0.0 (since WS19/20) Person responsible for module: Prof. Dr. Björn Schuller	
Learning Outcomes / Competences: Knowledge: The students learn concepts relating to signal processing, speech production, phonetics, speech and language pathology, feature extraction, denoising, information reduction and natural language processing as exemplified through the analysis of automated voice pathology detection. They further gain insight into machine learning principles, with a particular focus on deep learning solutions, as is needed to diagnose a range of different voice pathologies. They will learn about different problems and solutions in the analysis of a variety of speech, relevant in the context of health care and wellbeing. Skills: Participants are trained in their logical, analytical and conceptional skills as well as in practical programming skills to transfer their knowledge to a practical task. The students will be able to choose appropriate algorithms of signal processing and machine intelligence, further develop these, design new solutions, and apply these to the task of voice pathology detection. All knowledged obtained during the Praktikum is applied in practice-oriented tasks. Students will be able to assess developed systems in a scientific way. They will be able to recognise important technical evolution and novelties in the fields of speech analysis and medical machine learning. Competences: The students are able to characterise, judge on the quality and suitability, and design suited algorithmic solutions for intelligent signal analysis with a focus on voice pathology detection. They are further able to present and document results in a reasonable and meaningful way. Students will work in teams and organise their work and task distribution in an autonomous way. Key skills: Formal methods; Knowledge of advantages and disadvantages of different design alternatives; Systematical advancement of design tools; Ability to work in teams; Understanding of team management; Knowledge of workflows and processes; Ability to find solutions for practical problems; Ability to work autonomously; Quality awareness; Scientific working.	
Workload: Total: 150 h 60 h internship / practical course (attendance) 90 h studying of course content through exercises / case studies (self-study)	
Conditions: none	**Credit Requirements:** Passing the module exam

Frequency: irregular	**Recommended Semester:** from 3.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Speech Pathology
Mode of Instruction: internship
Language: English
Contact Hours: 4

Contents:

The course "Speech Pathology Praktikum" will give an introduction to models of speech production (e.g., source-filter models) with a focus on aspects that are relevant to pathologies and their recognition using automated methods of signal processing and machine learning. Moreover, students learn about robust feature extraction, modern methods of machine learning and machine intelligence, and implementation of such systems on devices

Topics: Speech production; Phonetics; Speech and language pathology; Signal processing; Natural language processing; Speech analysis; Feature extraction; Machine learning; Deep learning; Denoising; Information reduction; Healthcare.

Literature:

- Björn Schuller, Anton Batliner: "Computational Paralinguistics: Emotion, Affect and Personality in Speech and Language Processing", Wiley, ISBN: 978-1119971368, 2013.
- Further literature is going to be announced during the lecture.

Examination

Praktikum Speech Pathology

practical exam

Module INF-0327: Research Module IT Infrastructure in Medical Information Systems *Forschungsmodul IT-Infrastrukturen in der Medizin*	6 ECTS/LP
Version 1.0.0 (since WS19/20) Person responsible for module: Prof. Dr. Frank Kramer	
Learning Outcomes / Competences: After participating in the research module, students are able to understand problems of medium complexity in the field of IT infrastructures in translational medical research. They have detailed and up-to-date knowledge in the aforementioned field and can actively participate in research projects. To this end, they understand advanced concepts, methods, procedures, techniques and technologies and can apply this knowledge in research projects. In addition, students have the teamwork and communication skills, the ability to research literature and the learning and working techniques to discuss problems in the field, as well as to critically evaluate, combine and present intermediate results. Key Skills: Skill in logical, analytical, and conceptual thinking; Independent work with English-language literature; Understandable, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill in working in teams and understanding team processes; Principles of good scientific practice.	
Workload: Total: 180 h	
Conditions: none	**Credit Requirements:** Passing the module examination

Frequency: each semester	**Recommended Semester:** from 3.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Research Module IT Infrastructure in Medical Information Systems
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Current research topics in the field of IT infrastructures in translational medical research.

Literature:
scientific essays, manuals

Assigned Courses:

Oberseminar IT-Infrastrukturen für die Translationale Medizinische Forschung

Examination
Research Module IT Infrastructure in Medical Information Systems
practical exam

Module INF-0330: Seminar Computational Intelligence (Bachelor) *Seminar Computational Intelligence (Bachelor)*	4 ECTS/LP
Version 1.0.0 (since SoSe20) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:
After attending the seminar, students will be able to autonomously acquire and understand advanced problem statements, concepts, methods, approaches, techniques, and technologies in the field of Computational Intelligence. They possess the scientific techniques, communication skills, and the ability to employ suitable media, to present understandingly a special topic in spoken and written, and to discuss and evaluate scientifically challenging themes from the field in a critical way. Furthermore, they can recognise logical structures of thinking and debating and employ them constructively.
Participants can express themselves in a clear and understandable way and present scientific topics. They understand how to structure a talk, to focus it - also given a complex content - on the essential messages, and to communicate them in a suitable way. The lines of arguments and strategies in case of disturbances are applied by the students. Students know how to perform energetically, to cope with the presentation media and to use them interactively. They manage to orient a talk toward a certain audience, to motivate the listeners also over a longer duration, and to employ different methods of moderation.

Key qualifications: Fundamentals of good scientific practice; Analytical-methodological competency; Time management; Literature research; Self-contained work with English technical literature; Communication skills; Ability to present (in written and spoken) practical and theoretical ideas in an understandable, confident, and convincing way; Writing a report in the markup language LaTeX; Evaluation of methods, technologies, and solutions w.r.t. different aspects; Quality awareness.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Computational Intelligence (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
Fuzzy Logic, Neural Networks, Evolutionary Computation, Learning Theory, Probabilistic Methods

Literature:
To be announced by the lecturers.

Assigned Courses:

Seminar Computational Intelligence (Bachelor & Master) (seminar)

Examination

Seminar Computational Intelligence (Bachelor)

written/oral exam

Module INF-0332: Artificial Intelligence *Artificial Intelligence*	5 ECTS/LP
Version 1.1.0 (since SoSe20) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:
The course Artificial Intelligence covers the broad research area of artificial intelligence including the core topics Learning, Knowledge representation, Perception, Natural Language Processing, Socio-Emotional Intelligence, Artificial Creativity, Reasoning, Problem Solving, Planning, and General intelligence.
Upon completing the course, students will have the skills and knowledge to be able to choose suitable approaches and for specific tasks in artificial intelligence and know the pros and cons of design alternatives, as assessed in the respective application context. They will be able to apply and implement the discussed technical concepts in programs and systems.
During the course, the participants will improve their skills in logical, analytical, and conceptual thinking. Students will gain the ability to make scientifically meaningful assessments in the field of artificial intelligence using appropriate methods. They will get used to the way of thinking and the language of relevant disciplines.
Moreover, students will gain the ability to, convincingly, present their developed ideas and concepts. They will be able to apply their new knowledge to practical tasks and solve many real-life problems through the appropriate application of machine learning. They will also develop the competence to identify significant technical developments in the field.
Key qualifications: analytical skills, data science cross-disciplinary knowledge, procedures and processes in creating practical systems, ability to present and document results in a comprehensible way, skill to solve problems under practical conditions, self-reflection, quality awareness, meticulousness, teamwork

Workload:
Total: 150 h
15 h studying of course content using literarture (self-study)
15 h studying of course content using provided materials (self-study)
30 h lecture (attendance)
60 h studying of course content through exercises / case studies (self-study)
30 h exercise course (attendance)

Conditions:	**Credit Requirements:**
Knowledge of basic mathematic lectures should be present.	Bestehen der Modulprüfung

Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Artificial Intelligence (Vorlesung)
Mode of Instruction: lecture
Language: German
Contact Hours: 2

Contents:
Learning, Knowledge representation, Perception, Natural Language Processing, Socio-Emotional Intelligence, Artificial Creativity, Reasoning, Problem Solving, Planning, and General intelligence.

Literature:
Literature will be anounced during the lecture.

Part of the Module: Artificial Intelligence (Übung)
Mode of Instruction: exercise course
Language: English
Contact Hours: 2

Examination
Artificial Intelligence
written exam / length of examination: 90 minutes

Module INF-0334: Practical Module Human-Centered Artificial Intelligence for Health Care Applications *Praktikum Human-Centered Artificial Intelligence for Health Care Applications*	8 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After successful participation in this module, students are familiar with basic concepts of artificial intelligence for the development of health-related applications. They are able to translate technical solution concepts into models and master the selection and safe application of suitable methods. In addition, they will gain an insight into current work in the research field. Furthermore, competencies in the areas of teamwork and communication skills as well as self-organization are taught through the processing of project tasks and their independent project planning. In the context of these project tasks, knowledge of the mindset and language of the research field is fostered through the discussion and presentation of project results.

Key qualifications: Conversion of technical solution concepts into programs and models; subject-specific consolidation; interdisciplinary knowledge; ability to make scientifically meaningful evaluations using suitable methods; knowledge of the mindset and language of application-relevant disciplines; ability to work in teams; knowledge of practice-relevant tasks; familiarity with procedures and processes in the application environment of computer science; ability to present and document results in a comprehensible manner; ability to expand existing knowledge independently; competence in recognizing significant technical developments.

Workload:
Total: 240 h
150 h studying of course content through exercises / case studies (self-study)
90 h internship / practical course (attendance)

Conditions:
Programming experience

Frequency: each summer semester	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Human-Centered Artificial Intelligence for Health Care Applications
Mode of Instruction: internship
Language: German
Contact Hours: 6

Assigned Courses:

Praktikum Human-Centered Artificial Intelligence for Health Care Applications (internship)

Examination
Practical Module Human-Centered Artificial Intelligence for Health Care Applications
practical exam

Module INF-0336: Seminar Embedded Systems (Bachelor) *Seminar Embedded Systems (Bachelor)*	4 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Sebastian Altmeyer

Learning Outcomes / Competences:
After attending the seminar, students are able to independently work out and understand basic problems, concepts, methods, procedures, techniques and technologies in the field of embedded systems.

They have the working techniques, communication skills and ability to use appropriate media to present a special topic clearly and comprehensibly, both verbally and in writing, and to discuss topics from the aforementioned field critically and argumentatively. They will also be able to recognize and use logical structures of reasoning and argumentation in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a scientific presentation in a clear and comprehensible way and how to focus the presentation on essential messages and convey them in a comprehensible way.

The students understand how to present themselves and how to deal confidently with common presentation media. They manage to gear a presentation to a specific target group and to motivate the listener and to apply various moderation techniques.

Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and for their documentation; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Embedded Systems (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
In the seminar, topics from the field of embedded systems will be covered. Each seminar participant receives individual literature references, which are then to be supplemented in the course of the seminar by further independently compiled references. The seminar will end with a written paper and a presentation on the topic covered.

Literature:
given individually and self research

Assigned Courses:

Seminar Embedded Systems (Bachelor) (seminar)

Examination

Seminar Embedded Systems (Bachelor)

written/oral exam

Module INF-0338: Research Module Embedded Systems *Forschungsmodul Embedded Systems*	6 ECTS/LP
Version 1.0.0 (since SoSe20) Person responsible for module: Prof. Dr. Sebastian Altmeyer	

Learning Outcomes / Competences:
After participating in the research module, students are able to understand problems of medium complexity in the field of embedded systems. They have detailed and up-to-date knowledge in the aforementioned field and can actively participate in research projects. To this end, they understand advanced concepts, methods, procedures, techniques and technologies and can apply this knowledge in research projects. In addition, students have the teamwork and communication skills, the ability to research literature and the learning and working techniques to discuss problems in the field, as well as to critically evaluate, combine and present intermediate results.

Key qualifications: Skill in logical, analytical, and conceptual thinking; Independent work with English-language literature; Intelligible, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill in working in teams and understanding team processes; Principles of good scientific practice.

Workload:
Total: 180 h
15 h seminar (attendance)
165 h internship / practical course (self-study)

Conditions: none		
Frequency: each semester	**Recommended Semester:** 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Forschungsmodul Embedded Systems
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Participation in current research topics.

Literature:
scientific papers, handbooks

Assigned Courses:

Oberseminar Embedded Systems

Examination
Forschungsmodul Embedded Systems
practical exam

Module INF-0341: Seminar Digital Health (Bachelor) *Seminar Digital Health (Bachelor)*	4 ECTS/LP
Version 1.0.0 (since SoSe20) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:

After attending the seminar, students will be able to autonomously acquire and understand advanced problem statements, concepts, methods, approaches, techniques, and technologies in the field of Digital Health, E-Health and M-Health. They possess the scientific techniques, communication skills, and the ability to employ suitable media, to present understandingly a special topic in spoken and written, and to discuss and evaluate scientifically challenging themes from the field in a critical way. Furthermore, they can recognise logical structures of thinking and debating and employ them constructively.

Participants can express themselves in a clear and understandable way and present scientific topics. They understand how to structure a talk, to focus it - also given a complex content - on the essential messages, and to communicate them in a suitable way. The lines of arguments and strategies in case of disturbances are applied by the students. Students know how to perform energetically, to cope with the presentation media and to use them interactively. They manage to orient a talk toward a certain audience, to motivate the listeners also over a longer duration, and to employ different methods of moderation.

Key qualifications: Fundamentals of good scientific practice; Analytical-methodological competency; Time management; Literature research; Self-contained work with English technical literature; Communication skills; Ability to present (in written and spoken) practical and theoretical ideas in an understandable, confident, and convincing way; Writing a report in the markup language LaTeX; Evaluation of methods, technologies, and solutions w.r.t. different aspects; Quality awareness.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Digital Health (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:

In the seminar Digital Health, recent research works in this field are going to be discussed. This comprises both the acquisition of data through sensors and (e.g., microphones or electrodes) and the analysis and the modelling of the data. One important aspect is also the practicability of modern deep learning methods. Digital Health applications reach from tracking of health states (e.g., epilepsy or depression) to personal assistance services. The participating students will work on a certain aspect, supervised by a research associate of the chair. They will summarise their results in a written report and an oral presentation.

Topics: E-Health, M-Health, Sensor Signal Analysis, Vital Signs, Big Data.

Literature:

Depends on the chosen topic

Assigned Courses:

Seminar Digital Health (Bachelor & Master) (seminar)

Examination

Seminar Digital Health (Bachelor)

written/oral exam

Module INF-0343: Seminar Software Engineering of Distributed Systems (BA) *Seminar Software Engineering verteilter Systeme (BA)*	4 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students can independently analyze and evaluate advanced problems, concepts, methods, procedures, techniques, and technologies in distributed systems software engineering about the particular seminar topic from the named field. They have the scientific methodology, communication skills, and ability to use appropriate media to present a specific case clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably, focus the study on essential messages, and understandably convey them, even with complex content. They skillfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and confidently deal with joint presentation media and use them interactively. They manage to gear a lecture to a specific target group, motivate the listener even during longer lecture durations, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management. Translated with www.DeepL.com/Translator (free version)

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions:
The previous course "Seminar on Software Engineering of Distributed Systems (BA)" (INF-0026) must not have been taken due to overlaps.

Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Software Engineering verteilter Systeme (BA)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current software engineering topics from industry and research.

Literature:
Will be presented at the respective kick-off event.

Assigned Courses:

Seminar Software Engineering verteilter Systeme (Bachelor) (seminar)

Examination

Seminar Software Engineering verteilter Systeme (BA)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0345: Seminar Automotive Software and Systems Engineering (BA) *Seminar Automotive Software and Systems Engineering (BA)*	4 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students can independently work out and understand fundamental problems, concepts, methods, procedures, techniques, and technologies in automotive software & systems engineering. They have the working techniques, communication skills, and ability to use appropriate media to present a particular topic clearly and comprehensibly in speech and writing and discuss issues from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably, focus the study on important messages, and convey them in a comprehensible way. The students understand how to present themselves and deal confidently with joint presentation media. They manage to gear a lecture to a specific target group, motivate the listener, and apply various moderation techniques.

Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions:
The previous course "Seminar Fundamentals of Software Engineering for Automotive Systems (BA)" (INF-0027) must not have been taken due to overlaps.

Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Automotive Software and Systems Engineering (BA)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current software engineering topics from industry and research.

Literature:
Will be presented in the respective kick-off event.

Examination

Seminar Automotive Software and Systems Engineering (BA)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0347: Seminar Avionic Software and Systems Engineering (BA) *Seminar Avionic Software and Systems Engineering (BA)*	4 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students can independently analyze and evaluate advanced problems, concepts, methods, procedures, techniques, and technologies in Avionic Software & Systems Engineering about the particular seminar topic from the named field. They have the scientific methodology, communication skills, and ability to use appropriate media to present a specific case clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably focus the study on essential messages and convey them in a comprehensible way, even in the case of complex content. They skillfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and confidently deal with joint presentation media and use them interactively. They manage to gear a lecture to a specific target group, motivate the listener even during longer lecture durations, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management. Translated with www.DeepL.com/Translator (free version)

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions:
The previous course "Seminar Grundlagen des Software Engineering für Avionic Systems (BA)" (INF-0028) must not have been taken due to overlaps.

Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Avionic Software and Systems Engineering (BA)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current software engineering topics from industry and research.

Literature:
Will be presented in the respective kick-off event.

Examination

Seminar Avionic Software and Systems Engineering (BA)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0350: Practical Module Engineering 4.0

Praktikum Engineering 4.0

6 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr.-Ing. Johannes Schilp

Learning Outcomes / Competences:
After students have attended the module, they will be able to,
understand mechatronic development processes and the associated methods and process models
apply various tools for digital development processes themselves
design and use digital development processes with a focus on virtual commissioning
exercise agile development in practical projects
Key qualifications: Teamwork and communication skills, structured and conscientious work, application-oriented problem solving, evaluation of results and weighing of solution approaches, ability to think logically, analytically and conceptually

Workload:
Total: 180 h
120 h studying of course content through exercises / case studies (self-study)
60 h internship / practical course (attendance)

Conditions:		
Frequency: each summer semester	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Engineering 4.0
Mode of Instruction: internship
Language: German
Contact Hours: 4
ECTS Credits: 6.0

Contents:
Theory:
Basics of mechatronic and agile development
digital engineering
Output and discussion of the development task
Application:
Requirements analysis, concept phase, design, virtual commissioning, prototypical construction and implementation of a miniature packaging system.
agile development methodology Scrum (Sprint Planning, Sprint Review, Sprint Retrospective, Sprint Planning)
The internship takes place in the premises of our partner institute, the Fraunhofer IGCV in Augsburg. The participants are responsible for their own travel to and from the practical module.

Literature:

- Gloger, B.: Scrum. Produkte zuverlässig und schnell entwickeln. 4. Aufl. München: Hanser 2013. ISBN: 978-3-446-43338-0.
- Bracht, Uwe, Dieter Geckler, and Sigrid Wenzel. "Digitale Fabrik." Methoden und Praxisbeispiele, Berlin, Heidelberg (2011).

Assigned Courses:

Praktikum Engineering 4.0 (internship)

Examination

Practical Module Engineering 4.0

practical exam / length of examination: 60 minutes

Module INF-0352: Practical Module Biomedical Programming (Bachelor) *Praktikum Programmieren in der biomedizinischen Informatik (Bachelor)*	6 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Frank Kramer

Learning Outcomes / Competences:
After participation in the practical course Programming in Biomed. Informatics, students will understand practical problems of higher complexity in the field of software development and evaluations in the application areas of biomedical informatics. Students will gain in-depth subject-specific as well as cross-disciplinary knowledge and skills, for example bioinformatics, medical informatics and statistics. They are able to develop concepts, methods, techniques and technologies of the mentioned field in research projects and are able to apply innovative methods in solving problems. This enables them to link up with international research
and to make their own scientific contribution in this field. In addition, students have the teamwork and communication skills, the ability to research the literature and the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine, present and document intermediate results and innovative ideas in an understandable way.
Key Skills: Ability to think logically, analytically, and conceptually; Work independently with technical literature; Present ideas, concepts, and results in an understandable, confident, and persuasive manner; Quality awareness; Communication skills; Teamwork skills;

Remarks:
Wenn Sie bereits das Modul "INF-0325: Praktikum Grundlagen des Programmierens in der biomedizinischen Informatik" gehört haben, ist eine erneute Einbringung **nicht** möglich!

Workload:
Total: 180 h
30 h studying of course content through exercises / case studies (self-study)
30 h studying of course content using literarture (self-study)
90 h internship / practical course (attendance)
30 h studying of course content using provided materials (self-study)

Conditions: none		**Credit Requirements:** Passing the module examination
Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Biomedical Programming (Bachelor)
Mode of Instruction: internship
Language: German / English
Frequency: irregular (usu. summer semester)
Contact Hours: 6

Contents:

Participants of the Bio-/Medical Informatics Programming Internship will learn how to implement small application and infrastructure programs in a biological and medical context.

The goal of the internship is for students to develop various small programs in Python related to medical issues.

Through daily work assignments, students will acquire basic knowledge of:

- Python programming
- Use of biological/medical databases
- Data transformation in a biological and medical context
- Disease research in bio/medical informatics
- High throughput data analysis

The internship is offered as a 2-week block course during the semester break, consists of a short daily introduction to the current work tasks and subsequent independent implementation by the students.

During independent work, a supervisor will be present at designated times for assistance and questions.

There will be a one-time meeting during the semester for organizational reasons.

Examination

Practical Module Biomedical Programming (Bachelor)

practical exam / length of examination: 30 minutes

Module INF-0363: Seminar Software Engineering in Safety- and Security-Critical Systems (BA) *Seminar Software Engineering in sicherheitskritischen Systemen (BA)*	4 ECTS/LP

Version 1.0.0 (since WS20/21)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students can independently develop, analyze and evaluate advanced problems, concepts, methods, procedures, techniques, and technologies in software engineering in safety-critical systems and their related disciplines about the particular seminar topic from the named field. They have the scientific methodology, communication skills, and ability to use appropriate media to present a specific case clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably focus the study on important messages and understandably convey them, even in the case of complex content. They skillfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and confidently deal with joint presentation media and use them interactively. They manage to gear a lecture to a specific target group, motivate the listener even during longer lecture durations, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management. Translated with www.DeepL.com/Translator (free version)

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		
Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Software Engineering in Safety- and Security-Critical Systems (BA)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current software engineering topics from industry and research.

Literature:
Will be presented in the respective kick-off event.

Assigned Courses:

Seminar Software Engineering in sicherheitskritischen Systemen (Bachelor) (seminar)

Examination

Seminar Software Engineering in Safety- and Security-Critical Systems (BA)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0365: Practical Module Interaction Design and Engineering for Health Care Applications *Praktikum Interaction Design and Engineering for Health Care Applications*	8 ECTS/LP

Version 1.0.0 (since WS20/21)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
Students are familiar with methods and techniques of interaction design and engineering for health care applications. After successful participation, they will have the necessary knowledge to analyze application scenarios according to the guidelines of the user-centered design process and to design software solutions tailored to the target group. They are able to translate current interaction paradigms and design guidelines into models and programs for novel interaction devices, as well as to independently familiarize themselves with the necessary technologies. Furthermore, they are able to apply practice-relevant evaluation methods to assess the quality of the created software prototype. They are able to plan larger project tasks in small teams, solve them according to a self-developed project plan and discuss the results appropriately in plenary sessions and present them as a team.

Key qualifications: Skill in confident and persuasive presentation of ideas and concepts; knowledge of the mindset and language of application-relevant disciplines; understanding of team processes; skill in collaborating in teams; skill in leading teams; skill in presenting and documenting results in a comprehensible manner; ability to expand existing knowledge independently; ability to contribute to science; competence in recognizing significant technical developments; quality awareness, meticulousness.

Workload:
Total: 240 h
150 h studying of course content through exercises / case studies (self-study)
90 h internship / practical course (attendance)

Conditions: none		
Frequency: each winter semester	**Recommended Semester:** from 3.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Interaction Design and Engineering for Health Care Applications
Mode of Instruction: internship
Language: German
Contact Hours: 6

Contents:
The specific assignment for student projects is designed each year.

Literature:
Literature references will be announced at the beginning of the semester depending on the topic.

Examination
Practical Module Interaction Design and Engineering for Health Care Applications
practical exam

Module INF-0372: Research Module Resource Aware Algorithms *Forschungsmodul Resource Aware Algorithms*	6 ECTS/LP

Version 1.0.0 (since WS20/21)
Person responsible for module: Prof. Dr. Tobias Mömke

Learning Outcomes / Competences:
After attending this research module, the students are able to understand algorithmic problems and solutions of medium difficulty in the area of resource aware algorithmics.They have acquired a detailed understanding of up-to-date topics within the area and can actively participate in research projects. Furthermore, they understand some deep concepts, methods, tools and technologies and can apply the acquired knowledge in research projects. Besides the technical abilities, they train their team and communication skills, the ability to perform literature research and to discurss and present technical topics.

Key Qualifications: Ability to perform analytical and logic thinking; self-sufficient work with scientific literature in English language; ability to present results and ideas in form of understandable and inspiring presentations; aim for high-quality results; communication skills; ability to work with a team and to understand team processes; respect for clean scientific practices.

Workload:
Total: 180 h
165 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Forschungsmodul Resource Aware Algorithmics
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Contribution to research on state of the art research topics.

Literature:
scientific papers, books

Assigned Courses:

Oberseminar Resource Aware Algorithmics

Examination
Reseach Module Resource Aware Algorithmics
portfolio exam

Module INF-0384: Seminar Resource Aware Algorithms (Bachelor) *Seminar Resource Aware Algorithms (Bachelor)*	4 ECTS/LP

Version 1.0.0 (since SoSe21)
Person responsible for module: Prof. Dr. Tobias Mömke

Learning Outcomes / Competences:
After attending the seminar, the students are able to understand basic algorithmic concepts, methods, tools and techniques in a self-sufficient manner.

They have acquired communication skills, knowledge about work processes and the use of media to present a specific scientific topic both as a talk and in writte form.

The participants have learned to express techical contents in a sturctured, understandable and inspiring manner. They have learned to confidently stand in front of the audience, using state of the art presentation tools and media. They are able to tailor the talk to the respective audience.

Key Qualifications: Literature research; work with scientific literature in English language; analytic copetences; clean scientific practice; ability to present techincal content in confident, understandable and structured manner (both in written and spoken form); abstract, logical and analytical thinking; ability to argue formally; aim for high quality; communication skills; time management.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions:		**Credit Requirements:**
Good knowledge of content taught in mathematical Bachelor classes such as "Mathematik für Informatiker 1" and "Diskrete Strukturen und Logik." Knowledge about algorithms and data structures (Informatik 3) is useful.		Passing of Module exam
Frequency: irregular	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Resource Aware Algorithmics (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
The topics of the seminar are related to research in resource aware algorithmics. The precise topics change over time, in order to reflect up-to-date developments.

Literature:
Depending on the topic of the seminar.

Assigned Courses:

Seminar Resource Aware Algorithmics (Bachelor) (seminar)

Examination
Seminar Resource Aware Algorithmics (Bachelor)
written/oral exam

Module INF-0386: Practical Module Biomedical Analysis of Single Cell Data *Praktikum Biomedical Analysis of Single Cell Data*	8 ECTS/LP

Version 1.0.0 (since SoSe21)
Person responsible for module: Prof. Dr. Matthias Schlesner

Learning Outcomes / Competences:
In the practical course, students learn how to analyze and integrate single cell data across multiple omics levels. To answer current biological questions, students perform complex analysis workflows. During the course, creative problem solving approaches are developed in teams and professionally presented and documented. After participating in the course, students will be familiar with commonly used bioinformatical software packages and will be able to critically compare, extend, and combine available solutions in innovative ways. The students will be well versed in the application of common methods of dimensionality reduction and visualization, up to interactive visualization of high dimensional data. They will be familiar with current methods for pre-processing and quality assurance of data and will be able to combine data sets from different sources using appropriate batch corrections. They will know the basic methods for clustering single cell data and will be able to efficiently apply them to larger data sets using appropriate program libraries. They will be able to identify characteristic features of cell clusters, such as marker genes, using appropriate statistical methods. The students will be able to critically assess and appropriately apply advanced analyses from the field of pseudo-time analysis. They will be able to analyze multidimensional datasets across different omics levels in an integrated manner. This methodological knowledge builds on a biological understanding of the different underlying omics levels, including their interplay in the cell. As part of the course, students will examine the function of biological tissues and differentiation systems. They will be familiar with the current literature on this topic and will be able to develop their own analysis strategies using the current literature and evaluate them in their context. The students perform all these analysis tasks independently using Python and R and document their approach as well as their biological results in interactive notebooks.

Key Skills: Skills in logical, analytical, and conceptual thinking; Skills in solving programming tasks independently and learning new software packages using existing documentation; Skills in presenting ideas and concepts confidently and persuasively; Ability to work independently with technical literature; Ability to collaborate in teams; Ability to work independently with public databases; Ability to present results clearly;

Workload:
Total: 240 h
90 h internship / practical course (attendance)
30 h studying of course content using literarture (self-study)
30 h studying of course content using provided materials (self-study)
90 h studying of course content through exercises / case studies (self-study)

Conditions:	**Credit Requirements:**
Module Computer Science 1 (INF-0097) - recommended Module Bioinformatics 1 (INF-0402) - recommended Module Bioinformatics 2 (INF-0403) - recommended	Passing the module examination

Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 3.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Biomedical Analysis of Single Cell Data
Mode of Instruction: internship
Language: German / English
Contact Hours: 6

Contents:

- Biological principles for understanding current issues in the field of single cell data.
- Application of current bioinformatic program libraries and biostatistical methods for the analysis of single cell data sets
- Performance of complex analysis workflows, starting with the initial pre-processing of data, up to the integration of data from different omics levels
- Analysis and documentation with interactive notebooks (Jupyter or R Markdown)
- Data visualization

Assigned Courses:

Praktikum zu Biomedical analysis of single cell data (internship)

Examination
Praktikum Biomedical Analysis of Single Cell Data
portfolio exam

Module INF-0406: Seminar Digital Ethics (Bachelor) *Seminar Digitale Ethik (Bachelor)*	4 ECTS/LP

Version 1.0.0 (since WS21/22)
Person responsible for module: Prof. Dr. Robert Lorenz

Learning Outcomes / Competences:
After attending the seminar, the students can independently work out and analyse advanced problems, concepts, methods, procedures, techniques, and technologies from the field of digital ethics and evaluate them in relation to the individual seminar topic.

Participants possess scientific methodology, communication skills, and the ability to present a special topic clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively.

Furthermore, they learn to recognise logical structures of thinking and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a talk that is clear and easy to follow. Additionally, the students know how to focus on essential messages and convey them in a comprehensible way, even with complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to confidently deal with common presentation media and use them interactively. They manage to gear a talk to a specific target group, apply various moderation techniques, and keep their audience engaged even over a longer period.

Key qualifications: Presentation techniques; literature research; principles of good scientific practice; evaluating solution approaches, procedures, techniques, and technologies from different points of view.

Workload:
Total: 120 h
90 h preparation of presentations (self-study)
30 h seminar (attendance)

Conditions:	**Credit Requirements:**
Module Database Systems (INF-0073) - recommended Module Computer Science 1 (INF-0097) - recommended Module Computer Science 2 (INF-0098) - recommended Module Computer Science 3 (INF-0111) - recommended	Passing the module examination

Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Digital Ethics (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 4.0

Contents:
The topics change over time, in order to reflect up-to-date developments

Literature:
Literature depends on the chosen topic

Examination

Seminar Digital Ethics (Bachelor)

presentation / length of examination: 45 minutes

Module INF-0421: Seminar Organic Computing (Bachelor) *Seminar Organic Computing (Bachelor)*	4 ECTS/LP

Version 1.0.0 (since WS22/23)
Person responsible for module: Prof. Dr. Jörg Hähner

Learning Outcomes / Competences:
After attending the seminar, students are able to independently work out and understand basic problems, concepts, methods, procedures, techniques and technologies in the field of ad-hoc and sensor networks.

They possess the working techniques, communication skills and ability to use appropriate media to present a special topic clearly and comprehensibly in speech and writing and to discuss topics from the named field critically and argumentatively. Furthermore, they can recognise the logical structures of thinking and argumentation and use them in a goal-oriented manner.

Participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a presentation in a clear and reasonable way and how to focus the presentation on essential messages and convey them comprehensibly.

The students understand how to present themselves and how to deal confidently with common presentation media. They manage to gear a talk to a specific target group and to motivate the listener and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature;

Analytical-methodical competence; scientific methodology; principles of good scientific practice;

Ability to describe and document (practical and theoretical) ideas, concepts and results in a comprehensible, confident and convincing manner (written and oral); ability to think logically, abstractly, analytically and conceptually and to argue formally; quality awareness, meticulousness; communication skills; time management.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Organic Computing (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 4.0

Contents:
The topics of the seminar are determined each year and adapted to current trends.

Literature:
Literature depending on the current topics: scientific papers or books.

Assigned Courses:

Seminar Organic Computing (Bachelor) (seminar)

Examination

Presentation and written paper.

written/oral exam

Module INF-0423: Seminar Machine Learning (BA) *Seminar Machine Learning (BA)*	4 ECTS/LP

Version 1.0.0 (since WS22/23)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students are able to work out and understand fundamental problems, concepts, methods, procedures, techniques, and technologies in the field of Medical Information Sciences independently. They have the working techniques, communication skills, and the ability to use appropriate media to present a particular topic clearly and comprehensibly in speech and writing and discuss issues from the mentioned field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented.
The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably, focus the study on important messages, and convey them in a comprehensible way. The students understand how to present themselves and deal confidently with joint presentation media. They manage to gear a lecture to a specific target group, motivate the listener, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Machine Learning (Seminar)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
This seminar will cover the basics of Medical Information Sciences. Various topics are to be worked on which are to serve as a basis for a subsequent practical course.

Literature:
Will be presented in the respective kick-off event.

Assigned Courses:

Seminar Machine Learning (Bachelor) (seminar)

Examination

Presentation and written paper

written/oral exam

Test Frequency:

when a course is offered

Module INF-0426: Wearable Technology Applications in Healthcare *Wearable Technology Applications in Healthcare*	8 ECTS/LP

Version 1.0.0 (since WS22/23)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
Students are familiar with methods and techniques of interaction design and engineering for health care applications. After successful participation, they will have the necessary knowledge to analyze application scenarios according to the guidelines of the user-centered design process and to design software solutions tailored to the target group. They are able to translate current interaction paradigms and design guidelines into models and programs for novel interaction devices, as well as to independently familiarize themselves with the necessary technologies. Furthermore, they are able to apply practice-relevant evaluation methods to assess the quality of the created software prototype. They are able to plan larger project tasks in small teams, solve them according to a self-developed project plan and discuss the results appropriately in plenary sessions and present them as a team.

Key qualifications: Skill in confident and persuasive presentation of ideas and concepts; knowledge of the mindset and language of application-relevant disciplines; understanding of team processes; skill in collaborating in teams; skill in leading teams; skill in presenting and documenting results in a comprehensible manner; ability to expand existing knowledge independently; ability to contribute to science; competence in recognizing significant technical developments; quality awareness, meticulousness.

Workload:
Total: 240 h
15 h studying of course content using provided materials (self-study)
15 h studying of course content using literarture (self-study)
120 h studying of course content through exercises / case studies (self-study)
30 h lecture (attendance)
60 h exercise course (attendance)

Conditions: Programming experience		
Frequency: each winter semester	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Interaction Design and Engineering for Health Care Applications
Mode of Instruction: lecture
Language: English
Frequency: each summer semester
Contact Hours: 2

Contents:
The specific assignment for student projects is designed each year.

Literature:
Literature references will be announced at the beginning of the semester depending on the topic.

Part of the Module: Wearable Technology Applications in Healthcare (Exercise Course)
Mode of Instruction: exercise course
Language: English
Contact Hours: 4

Examination
Practical Module Interaction Design and Engineering for Health Care Applications
portfolio exam

Module INF-0435: Research Module Quantum Algorithms

Forschungsmodul Quantenalgorithmen

6 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Jakob Siegfried Kottmann

Learning Outcomes / Competences:
Nach der Teilnahme am Forschungsmodul sind die Studierenden in der Lage, Problemstellungen mittlerer Komplexität auf dem Gebiet der Quantenalgorithmen verstehen. Sie verfügen über detailliertes und aktuelles Wissen auf dem genannten Gebiet und können in Forschungsprojekten aktiv mitarbeiten. Dazu verstehen sie weiterführende Konzepte, Methoden, Verfahren, Techniken und Technologien und können dieses Wissen in Forschungsprojekten einbringen. Außerdem verfügen die Studierenden über die Team- und Kommunikationsfähigkeit, die Fähigkeit zur Literaturrecherche und die Lern- und Arbeitstechniken, um Problemstellungen auf dem Gebiet zu diskutieren, sowie Zwischenergebnisse kritisch zu bewerten, zu kombinieren und zu präsentieren.

Schlüsselqualifikationen: Fertigkeit zum logischen, analytischen und konzeptionellen Denken; Eigenständige Arbeit mit englischsprachiger Fachliteratur; Verständliche, sichere und überzeugende Präsentation von Ideen, Konzepten und Ergebnissen; Qualitätsbewußtsein; Kommunikationsfähigkeit; Fertigkeit der Zusammenarbeit in Teams und Verstehen von Teamprozessen; Grundsätze guter wissenschaftlicher Praxis

Workload:
Total: 180 h
165 h internship / practical course (self-study)
1 h seminar (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: as needed	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Forschungsmodul Quantenalgorithmen
Mode of Instruction: internship
Language: English / German
Contact Hours: 1

Contents:
Mitarbeit an aktuellen Forschungsthemen

Literature:
Abhängig vom jeweiligen Thema

Assigned Courses:

Oberseminar Quantenalgorithmik

Examination
Forschungsmodul Quantenalgorithmen
practical exam
Test Frequency:
when a course is offered

Module INF-0438: Seminar Quantum Algorithms (Bachelor) *Seminar Quantenalgorithmen (Bachelor)*	4 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Jakob Siegfried Kottmann

Contents:
Im Seminar werden die Inhalte aus der Vorlesung "Grundlagen der Quanteninformationsverarbeitung" vertieft. Der parallele Besuch der Vorlesung wird empfohlen. Spezifische Themen orientieren sich an aktueller Forschung. Hierbei werden in der Vorlesung aufgegriffene Anwendungsbeispiele und Themenfelder vertieft oder neue Themenfelder erschlossen. Das Seminar eignet sich als Vorbereitung einer Abschlussarbeit im Bereicht der Quantenalgorithmik.

Learning Outcomes / Competences:
Nach dem Besuch des Seminars sind die Studierenden in der Lage, grundlegende Problemstellungen, Konzepte, Methoden, Verfahren, Techniken und Technologien auf dem Gebiet der Quantenalgorithmen selbstständig zu erarbeiten und zu verstehen.
Sie verfügen über die Arbeitstechniken, Kommunikationsfähigkeit und Fähigkeit zum Einsatz entsprechender Medien, um ein spezielles Thema in Wort und Schrift klar und verständlich zu präsentieren und Themenstellungen aus dem genannten Gebiet kritisch und argumentativ zu diskutieren. Außerdem können sie die logischen Strukturen des Denkens und Argumentierens erkennen und zielführend einsetzen.
Die Teilnehmenden können klar und verständlich formulieren und Fachinhalte frei vortragen. Sie verstehen es, einen Vortrag klar und nachvollziehbar zu strukturieren und den Vortrag auf wesentliche Botschaften auszurichten und diese verständlich zu vermitteln.
Die Studierenden verstehen es, präsent aufzutreten und souverän mit gängigen Präsentationsmedien umzugehen. Sie schaffen es, einen Vortrag auf eine bestimmte Zielgruppe auszurichten und den Zuhörer zu motivieren und verschiedene Moderationstechniken anzuwenden.

Schlüsselqualifikationen: Literaturrecherche; Eigenständiges Arbeiten mit englischsprachiger Fachliteratur; Analytisch-methodische Kompetenz; Wissenschaftliche Methodik; Grundsätze guter wissenschaftlicher Praxis; Fertigkeit der verständlichen, sicheren und überzeugenden (schriftlichen und mündlichen) Darstellung von (praktischen oder theoretischen) Ideen, Konzepten und Ergebnissen und zu deren Dokumentation; Fertigkeit zum logischen, abstrakten, analytischen und konzeptionellen Denken und formaler Argumentation; Qualitätsbewußtsein, Akribie; Kommunikationsfähigkeit; Zeitmanagement

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each summer semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Quantenalgorithmen (Bachelor)
Mode of Instruction: seminar
Language: English / German
Contact Hours: 2

Contents:
Die Themen des Seminars werden jedes Mal neu festgelegt und aktuellen Entwicklungen angepasst.

Literature:

Abhängig vom gewählten Thema

Assigned Courses:

Seminar Quantenalgorithmen (Bachelor) (seminar)

Examination

Seminar Quantenalgorithmen (Bachelor)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0442: Seminar on Theory of distributed and parallel Systems (Bachelor) *Seminar Theorie verteilter und paralleler Systeme (Bachelor)*	4 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Kirstin Peters

Learning Outcomes / Competences:
Nach dem Besuch des Seminars sind die Studierenden in der Lage, grundlegende Problemstellungen, Konzepte, Methoden, Verfahren, Techniken und Technologien auf dem Gebiet der Theorie verteilter und paralller Systeme selbstständig zu erarbeiten und zu verstehen.
Sie verfügen über die Arbeitstechniken, Kommunikationsfähigkeit und Fähigkeit zum Einsatz entsprechender Medien, um ein spezielles Thema in Wort und Schrift klar und verständlich zu präsentieren und Themenstellungen aus dem genannten Gebiet kritisch und argumentativ zu diskutieren. Außerdem können sie die logischen Strukturen des Denkens und Argumentierens erkennen und zielführend einsetzen.
Die Teilnehmenden können klar und verständlich formulieren und Fachinhalte frei vortragen. Sie verstehen es, einen Vortrag klar und nachvollziehbar zu strukturieren und den Vortrag auf wesentliche Botschaften auszurichten und diese verständlich zu vermitteln.
Die Studierenden verstehen es, präsent aufzutreten und souverän mit gängigen Präsentationsmedien umzugehen. Sie schaffen es, einen Vortrag auf eine bestimmte Zielgruppe auszurichten und den Zuhörer zu motivieren und verschiedene Moderationstechniken anzuwenden.

Schlüsselqualifikationen: Literaturrecherche; Eigenständiges Arbeiten mit englischsprachiger Fachliteratur; Analytisch-methodische Kompetenz; Wissenschaftliche Methodik; Grundsätze guter wissenschaftlicher Praxis; Fertigkeit der verständlichen, sicheren und überzeugenden (schriftlichen und mündlichen) Darstellung von (praktischen oder theoretischen) Ideen, Konzepten und Ergebnissen und zu deren Dokumentation; Fertigkeit zum logischen, abstrakten, analytischen und konzeptionellen Denken und formaler Argumentation; Qualitätsbewußtsein, Akribie; Kommunikationsfähigkeit; Zeitmanagement

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions:		**Credit Requirements:**
Module Introduction to Theory of Computation (INF-0110) - recommended		Bestehen der Modulprüfung
Frequency: each summer semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Theorie verteilter und paralleler Systeme (Bachelor)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Die Themen des Seminars werden jedes Mal neu festgelegt und aktuellen Entwicklungen angepasst.

Literature:
Abhängig vom gewählten Thema

Examination

Seminar Theorie verteilter und paralleler Systeme (Bachelor)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0445: Seminar Software and Artificial Intelligence for Production Systems (Bachelor) *Seminar Software und Künstliche Intelligenz in der Produktion (Bachelor)*	4 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Wolfgang Reif

Learning Outcomes / Competences:
After completion of the seminar, students are able to understand basic problems, concepts, methods, procedures, techniques and technologies in the field of Internet security and independently learn new such concepts.

They have the working techniques, communication skills and ability to use appropriate media to present this field clearly and comprehensibly in speech and writing and to discuss topics from the mentioned field critically. They will also be able to recognize the logical structures of reasoning and argumentation and use them.

The participants are able to formulate clearly and understandably and to present specialist knowledge freely. They understand how to structure a presentation in a clear and comprehensible way and how to focus the presentation on the core messages and convey them in a comprehensible way.

The students understand how to present themselves and how to work with common presentation media. They manage to focus a presentation to a specific target group and to motivate the audience.

Soft Skills:

- Literature research
- Independently work with English technical literature
- Analytical competence
- Working methodical
- Principles of good scientific practice
- Ability to present (written and oral) ideas, concepts and results in a comprehensible and convincing manner and to document them
- Ability to think logically, abstractly, analytically and conceptually and to argue precisely
- Awareness for quality aspects
- Communication skills
- Time management

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions:
none

Frequency: irregular	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Internet Security
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:

The specific topics of the seminar deal with the security of computer systems on the Internet and they change from year to year to adapt to current developments.

Literature:

Depends on the concrete topic.

Assigned Courses:

Seminar zu Software und Künstliche Intelligenz in der Produktion (Bachelor) (seminar)

Examination

Seminar Internet Security

written/oral exam / length of examination: 45 minutes

work period for assignment: 3 months

Test Frequency:

when a course is offered

Module INF-0447: Seminar on Concurrent Systems (Bachelor)

Seminar zu nebenläufigen Systemen (Bachelor)

4 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Robert Lorenz

Learning Outcomes / Competences:
After attending the seminar, the students can independently work out and analyse advanced problems, concepts, methods, procedures, techniques, and technologies from the field of digital ethics and evaluate them in relation to the individual seminar topic.

Participants possess scientific methodology, communication skills, and the ability to present a special topic clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively.

Furthermore, they learn to recognise logical structures of thinking and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a talk that is clear and easy to follow. Additionally, the students know how to focus on essential messages and convey them in a comprehensible way, even with complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to confidently deal with common presentation media and use them interactively. They manage to gear a talk to a specific target group, apply various moderation techniques, and keep their audience engaged even over a longer period.

Key qualifications: Presentation techniques; literature research; principles of good scientific practice; evaluating solution approaches, procedures, techniques, and technologies from different points of view.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of presentations (self-study)

Conditions:
Module Computer Science 1 (INF-0097) - recommended
Module Computer Science 2 (INF-0098) - recommended
Module Discrete structures and logic (INF-0266) - recommended

Credit Requirements:
Passing the module examination

Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Digital Ethics (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 4.0

Contents:
The topics change over time, in order to reflect up-to-date developments

Literature:
Literature depends on the chosen topic

Examination

Seminar Digital Ethics (Bachelor)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0449: Practical Module „leightweight design“ (Bachelor Program) *Praktikum Leichtbau für Bachelor*	8 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Christoph Ament

Learning Outcomes / Competences:
After completing the practical course "Measurement and Control Engineering", students have detailed and up-to-date knowledge in this field. They understand basic concepts, methods, procedures, techniques and technologies in the field of measurement and control engineering in order to apply them in development projects.
Students are able to analyze the behavior of dynamic systems experimentally (e.g. record a step response or a Bode diagram of systems) and use this to create models for numerical simulations. They can apply methods for sensor signal processing and design a model-based controller and put them into operation in a closed loop system.
They also have the ability to work and communicate as a team to discuss problems in the field and to present issues and findings.

Workload:
Total: 240 h
90 h internship / practical course (attendance)
150 h studying of course content through exercises / case studies (self-study)

Conditions: Empfohlen: die erfolgreiche Teilnahme an der Vorlesung Systemdynamik und Regelungstechnik bzw. Mess- und Regelungstechnik		
Frequency: each summer semester	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Leichtbau für Bachelor
Mode of Instruction: internship
Language: German
Contact Hours: 6
ECTS Credits: 8.0

Contents:
n the practical course, 3 to 4 experiments are offered on each of the following topics:
Basics of scientific computing in Matlab, especially treatment of dynamic systems in Matlab and Simulink
Sensor signal processing, experimental analysis and identification of dynamic systems
Design and realization of control systems
Each group works on a computer with the software package Matlab. A microcontroller board is connected via a USB connection, on which algorithms for signal processing and control can be executed and which is used for the measurement of signals and control of the track at runtime. If necessary, different tracks are connected to the board for the respective experiments.

Lehr-/Lernmethoden:
Praktikumsversuche in Kleingruppen.

Literature:
Wird bezogen auf das Projektthema während des Praktikums mitgeteilt.

Assigned Courses:

Praktikum Leichtbau für Bachelor (internship)

Examination

Praktikum Leichtbau für Bachelor

portfolio exam

Test Frequency:

when a course is offered

Module INF-0452: Seminar Diagnostic Sensing (Bachelor) *Seminar Diagnostische Sensorik (Bachelor)*	4 ECTS/LP
Version 1.0.0 (since SoSe23) Person responsible for module: Prof. Dr. Sebastian Zaunseder	

Learning Outcomes / Competences:
Nach dem Besuch des Seminars sind die Studierenden in der Lage, grundlegende Problemstellungen, Konzepte, Methoden, Verfahren, Techniken und Technologien auf dem Gebiet der Diagnostischen Sensorik selbstständig zu erarbeiten und zu verstehen.
Sie verfügen über die Arbeitstechniken, Kommunikationsfähigkeit und Fähigkeit zum Einsatz entsprechender Medien, um ein spezielles Thema in Wort und Schrift klar und verständlich zu präsentieren und Themenstellungen aus dem genannten Gebiet kritisch und argumentativ zu diskutieren. Außerdem können sie die logischen Strukturen des Denkens und Argumentierens erkennen und zielführend einsetzen.
Die Teilnehmenden können klar und verständlich formulieren und Fachinhalte frei vortragen. Sie verstehen es, einen Vortrag klar und nachvollziehbar zu strukturieren und den Vortrag auf wesentliche Botschaften auszurichten und diese verständlich zu vermitteln.
Die Studierenden verstehen es, präsent aufzutreten und souverän mit gängigen Präsentationsmedien umzugehen. Sie schaffen es, einen Vortrag auf eine bestimmte Zielgruppe auszurichten und den Zuhörer zu motivieren und verschiedene Moderationstechniken anzuwenden.

Schlüsselqualifikationen: Literaturrecherche; Eigenständiges Arbeiten mit englischsprachiger Fachliteratur; Analytisch-methodische Kompetenz; Wissenschaftliche Methodik; Grundsätze guter wissenschaftlicher Praxis; Fertigkeit der verständlichen, sicheren und überzeugenden (schriftlichen und mündlichen) Darstellung von (praktischen oder theoretischen) Ideen, Konzepten und Ergebnissen und zu deren Dokumentation; Fertigkeit zum logischen, abstrakten, analytischen und konzeptionellen Denken und formaler Argumentation; Qualitätsbewußtsein, Akribie; Kommunikationsfähigkeit; Zeitmanagement

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Diagnostische Sensorik (Bachelor)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 4.0

Contents:
Die Themen des Seminars werden jedes Mal neu festgelegt und aktuellen Entwicklungen angepasst.

Literature:
Abhängig vom gewählten Thema

Assigned Courses:

Seminar Diagnostische Sensorik (Bachelor) (seminar)

Examination

INF-8006 Seminar Diagnostische Sensorik (Bachelor)

Test Frequency:

when a course is offered

Module GEO-4250: Lecture Integrative Geography *Vorlesung Integrative Geographie*		5 ECTS/LP
Version 2.0.0 (since WS22/23) Person responsible for module: Prof. Dr. Matthias Schmidt		
Contents: The lecture provides an introduction and an overview of the field of integrative geography (also referred to as the "third pillar" or "human-environmental geography"). Basic topics and current research and questions from physical geography and human geography are treated with a nexus to space, environment and society. Presentation of central problem complexes and their current political and socio-economic relevance, discussion of relevant questions, classification of integrative geography in the history of the discipline and current research landscape. The diverse interactions between space, environment and society are presented in their specific natural and socially regionally differentiated forms using selected current case studies.		
Learning Outcomes / Competences: After successfully completing the module, the students have in-depth knowledge of the various approaches, theories and perspectives of integrative geography. They are able to deal critically with current topics in the field of integrative geography, to assess and interpret them.		
Workload: Total: 150 h		
Conditions: none		**Credit Requirements:** Pass the module exam
Frequency: each winter semester winter semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module
Part of the Module: Vorlesung Integrative Geographie / Lecture Integrative Geography **Mode of Instruction:** lecture **Language:** German / English
Examination **GEO-4250 Integrative Geographie** module exam, module exam

Module GEO-4251: Discourse Analysis *Diskursanalyse*		5 ECTS/LP
Version 2.0.0 (since WS22/23) Person responsible for module: Dr. Andreas Benz		
Contents: Theoretical and conceptual foundations of discourse analysis, concrete micro- and macro-analytical procedures and methods of discourse analysis as well as fields of application and case studies of discourse analysis procedures.		
Learning Outcomes / Competences: After successfully completing the module, the students have in-depth knowledge of the theoretical foundations of discourse analysis methods. They know and master different methods of discourse analysis and are able to apply them independently to concrete empirical cases.		
Workload: Total: 150 h		
Conditions: none		**Credit Requirements:** Pass the module exam
Frequency: annually usually in summer semester	**Recommended Semester:** 1. - 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Diskursanalyse / Discourse Analysis
Mode of Instruction: lecture, exercise course, seminar, internship
Language: German / English

Assigned Courses:

Diskursanalyse - Discourse Analysis (exercise course)

Examination
GEO-4251 Diskursanalyse
module exam, Klausur, mündliche Prüfung, Hausarbeit, Übungsaufgabe oder Bericht
Description:
written exam, oral exam, scientific term paper, practice assignment or report

Module GEO-4253: Remote Sensing in Geosciences *Geowissenschaftliche Fernerkundung*		5 ECTS/LP
Version 2.0.0 (since WS22/23) Person responsible for module: Prof. Dr. Wolfgang Buermann		
Contents: This module offers students the opportunity to master the processes for acquiring, analyzing and interpreting geodata from different sensor platforms using specific software. Remote sensing geodata from various remote sensing platforms and sensors are used.		
Learning Outcomes / Competences: Students are able to describe and categorize data recorded by remote sensing, to distinguish between different sensor concepts and to adequately evaluate sensor data. In particular, they know the typical processing, calibration and validation strategies in the context of remote sensing. You will also, at least in some cases, acquire in-depth knowledge of the necessary software solutions and have used this software in exercises.		
Workload: Total: 150 h		
Conditions: none		**Credit Requirements:** Pass the module exam
Frequency: annually	**Recommended Semester:** 1. - 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Geowissenschaftliche Fernerkundung / Remote Sensing in Geosciences

Mode of Instruction: lecture, exercise course, seminar, internship

Language: German / English

Assigned Courses:

Satellitenfernerkundung - Remote Sensing (seminar)

Examination

GEO-4253 Geowissenschaftliche Fernerkundung

module exam, Klausur, Hausarbeit, mündliche Prüfung, Übungsaufgabe oder Bericht

Description:

written exam, scientific term paper, oral exam, practical exercise or report

Module GEO-4254: Modelling in Geosciences *Geowissenschaftliche Modellierung*	5 ECTS/LP
Version 2.0.0 (since WS22/23) Person responsible for module: PD Dr. Andreas Philipp	
Contents: The course includes the programming implementation and efficient application of advanced geoscientific methods for data preparation, analysis and visualization using the "R" programming environment. The exercises are carried out using data sets and content-related questions from various sub-areas of geography and geosciences.	
Learning Outcomes / Competences: After completing the module, the students can also efficiently prepare complex geoscientific data sets independently with the help of advanced programming technology. They are able to independently design problem-related geographic and geoscientific data analyzes and visualizations with the help of R, implement them efficiently in terms of programming and use them appropriately.	
Workload: Total: 150 h	
Conditions: none	**Credit Requirements:** Pass the module exam

Frequency: annually usually winter and summer semester	**Recommended Semester:** 1. - 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Geowissenschaftliche Modellierung / Modelling in Geosciences

Mode of Instruction: exercise course, internship

Language: German / English

Assigned Courses:

Dicke Luft - Feinstaub, Ozon und Stickoxide verstehen und modellieren - Bad atmosphere - understanding and modeling particulate matter, ozone and nitrogene oxide (exercise course)

Hydrologische Modellierung - Hydrological Modeling (exercise course)

Examination

GEO-4254 Geowissenschaftliche Modellierung

module exam, mündliche Prüfung, Übungsaufgabe oder Bericht

Description:

oral exam, exercise or report

Module GEO-4255: Programming in Geosciences *Geowissenschaftliche Programmierung*		5 ECTS/LP
Version 2.0.0 (since WS22/23) Person responsible for module: Prof Dr. Christoph Beck		
Contents: The course includes the programming implementation and efficient application of advanced geoscientific methods for data preparation, analysis and visualization using the "R" programming environment. The exercises are carried out using data sets and content-related questions from various sub-areas of geography and geosciences.		
Learning Outcomes / Competences: After completing the module, the students can also efficiently prepare complex geoscientific data sets independently with the help of advanced programming technology. They are able to independently design problem-related geographic and geoscientific data analyzes and visualizations with the help of R, implement them efficiently in terms of programming and use them appropriately.		
Workload: Total: 150 h		
Conditions: none		**Credit Requirements:** Pass the module exam
Frequency: annually usually winter and summer semester	**Recommended Semester:** 1. - 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Geowissenschaftliche Programmierung / Programming in Geosciences
Mode of Instruction: exercise course, internship
Language: German / English

Examination
GEO-4255 Geowissenschaftliche Modellierung
module exam, mündliche Prüfung, Übungsaufgabe oder Bericht
Description:
oral exam, exercise or report

Module GEO-5122: Geoinformatics 1

Geoinformatik 1 (10LP)

10 ECTS/LP

Version 2.0.0 (since WS22/23)
Person responsible for module: Prof. Dr. Sabine Timpf

Contents:
In GIScience geodata is at the core of many applications. However, geodata can only be interpreted within a specific context where models are needed to produce answers to questions. In fact, the models that are hidden beneath a data collection effort are of as much interest and importance as the models used to derive additional knowledge (such as weather forecast models, models of erosion, models of migration patterns, models of transportation systems or models of wayfinding). Every one of us models every day for everyday purposes. Understanding how this modeling happens and how to make these models better as well as computationally tractable helps to become clearer thinkers and expert modelers in GIScience.

This module introduces the theoretical foundations of modeling from different viewpoints. It also shows how modeling of geographic information adds a temporal component, leading towards simulation models. It then goes on to deal with the issue of modeling complex systems using a specific type of simulation with a software called Netlogo. After becoming proficient in modeling and simulating, there is a need to evaluate the validity and interpret the results of these implemented models. Using a combination of ground-truthing in case studies as well as sensitivity analysis, the advantages but also the limitations of this modeling approach in GIScience.

Learning Outcomes / Competences:
The learning objectives of this module are a critical understanding of the issues of modeling and simulation in GIScience, a proficiency in spatio-temporal modeling using a multi-agent simulation framework, the ability to abstract from a concrete problem and implement the best model for the solution of the problem, the expert knowledge of how to validate and evaluate a simulation model.

Workload:
Total: 300 h

Conditions:		**Credit Requirements:**
none		Pass the module exam
Frequency: each winter semester	**Recommended Semester:** 1. - 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Modelling and Simulation
Mode of Instruction: seminar
Language: English
Contact Hours: 2
ECTS Credits: 5.0

Part of the Module: Exercises Modelling and Simulation
Mode of Instruction: exercise course
Language: English
Contact Hours: 2
ECTS Credits: 5.0

Examination
Geoinformatik 1: Modelling and Simulation (MScGI)
project work

Module GEO-5129: Geoinformatics 2 *Geoinformatik 2*	10 ECTS/LP
Version 2.0.0 (since WS22/23) Person responsible for module: Prof. Dr. Jukka Krisp	
Contents: Introduction to visual and computer-aided methods of geographic data analysis. Exercises on the computer under guidance with geodata and mining software.	
Learning Outcomes / Competences: After attending this module, the students have become acquainted with computer-aided methods of geoinformatics for visual geodata analysis. You have acquired the ability to describe processes with the help of functional mechanisms and approaches. You have developed a functional set of tools for the visual analysis and processing of geographic data and can use this in specific cases. You can transfer the results of the assignment to similar problems and evaluate them critically.	
Workload: Total: 300 h	

Conditions: none		**Credit Requirements:** Pass the module exam
Frequency: each semester part 1 each semester, part 2 in summer semester	**Recommended Semester:** 2. - 3.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Vorlesung/Seminar zu Geodatenanalyse
Mode of Instruction: lecture, seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 5.0

Assigned Courses:

Visual Geodata Mining (VGDM) (seminar)

Part of the Module: Übung/Seminar zu Geodatenanalyse
Mode of Instruction: exercise course, seminar
Language: German / English
Frequency: each summer semester
Contact Hours: 2
ECTS Credits: 5.0

Assigned Courses:

Advanced spatial analysis - Advanced spatial analysis (exercise course)

Examination
Geoinformatik 2: Geodatenanalyse (MScGI)
portfolio exam, Module exam

Module GEO-5135: Climate 1 *Klima 1*		10 ECTS/LP
Version 2.0.0 (since WS22/23) Person responsible for module: Prof Dr. Christoph Beck		
Contents: Basic facts and problem contexts from the subject area of climate system and climate change or from the research areas treated with substantial-supporting reference to this subject area. In the associated accompanying seminar, content from the special lecture will be taken up and treated in addition.		
Learning Outcomes / Competences: Acquiring basic knowledge on research areas that either directly address the topic of the climate system and climate change or contain a substantial connection to it; problem-oriented treatment of associated questions in short presentations and contributions to discussions.		
Remarks: Lecture with accompanying seminar		
Workload: Total: 300 h		
Conditions: none		**Credit Requirements:** Pass the module exam
Frequency: each winter semester winter term	**Recommended Semester:** 1. - 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Spezialvorlesung
Mode of Instruction: lecture
Language: German / English
Contact Hours: 2
ECTS Credits: 5.0

Literature:

IPCC (Intergovernmental Panel on Climate Change): Climate Change 2013. The Physical Science Basis. Fifth Assessment Report, Contribution of Working Group I.

Part of the Module: Begleitseminar
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 5.0

Examination
Klima 1

written exam / length of examination: 90 minutes

Module INF-0037: Practical Module Automotive Software Engineering *Praktikum Automotive Software Engineering*	6 ECTS/LP
Version 1.0.0 (since SoSe13) Person responsible for module: Prof. Dr. Bernhard Bauer	

Learning Outcomes / Competences:
After participating in the practical course Automotive Software Engineering, the students understand practical problems of higher complexity in the field of development and validation of driving assistance systems with current methods and tools of model-based development of embedded systems. The students acquire in-depth subject-specific and interdisciplinary knowledge and skills, such as control engineering, driving physics, and mathematics. They are able to develop concepts, methods, techniques, and technologies of the mentioned field in research projects and are able to apply innovative approaches in solving problems. This enables them to link up with international research and make their scientific contribution to the field. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the area, define intermediate goals, and critically evaluate, classify, combine, present and document intermediate results and innovative ideas understandably.

Key qualifications: Ability to think logically, analytically, and conceptually; Independent work with English-language technical literature; Understandable, confident, and convincing presentation of ideas, concepts, and results; Quality awareness; Communication skills; Ability to work in teams and understand team processes; Project management skills.

Workload:
Total: 180 h
90 h internship / practical course (attendance)
90 h studying of course content through exercises / case studies (self-study)

Conditions:
Empfohlen wird die Teilnahme an einem der beiden links aufgeführten Seminare.

Module Seminar Basics of Software Engineering for Automotive Systems (BA) (INF-0027) - recommended
Module Seminar Basics of Software Engineering for Automotive Systems (MA) (INF-0040) - recommended

Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Automotive Software Engineering (MA)
Mode of Instruction: internship
Language: German
Frequency: each winter semester
Contact Hours: 6

Contents:

In the automotive practical course, participants learn how various selected functions within vehicles can be simulated and analyzed. The necessary theoretical foundations are laid for working on the experimental task in a two-day introductory course. The anti-lock braking system (ABS) model is treated on control units during the initial period. Among other things, the participants will get to know the modeling tool combination "Matlab/Simulink", which is frequently used in the automotive environment, and the graphical simulation and analysis tool "CarMaker" and gain a practical insight into the functioning of FlexRay bus systems.

After the introductory course, the model of an ACC (Adaptive Cruise Control) system will be created, simulated, and verified in groups of two to three participants.

Literature:

depending on the subject

Examination

Praktikum Automotive Software Engineering (MA)

oral exam / length of examination: 30 minutes

Test Frequency:

when a course is offered

Module INF-0042: Project Module Software Methodologies for Distributed Systems *Projektmodul Softwaremethodiken für verteilte Systeme*	10 ECTS/LP
Version 1.0.0 (since SoSe13) Person responsible for module: Prof. Dr. Bernhard Bauer	

Learning Outcomes / Competences:

After participating in the project module, students understand problems of higher complexity in the field of software methodologies for distributed systems and have in-depth specialist knowledge and skills there. They are able to develop concepts, methods, procedures, techniques, and technologies of the mentioned field in research projects and are able to apply innovative approaches in solving problems. This enables them to link up with international research and make their scientific contribution to the field. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the area, define intermediate goals, and critically evaluate, classify, combine and present intermediate results and innovative ideas.

Key qualifications: Ability to think logically, analytically, and conceptually; Independent work with literature; Understandable, confident, and convincing presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill of working in teams and understanding team processes; Principles of good scientific practice; Project management skills; Scientific methodology;

Workload:

Total: 300 h
15 h seminar (attendance)
285 h internship / practical course (self-study)

Conditions: none		
Frequency: each semester	**Recommended Semester:** 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projektmodul Softwaremethodiken für verteilte Systeme

Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:

Current research topics at the Software Methodology for Distributed Systems Lab

Literature:

Provided for the respective topics.

Assigned Courses:

Oberseminar zu Softwaremethodik für verteilte Systeme

Examination

Project acceptance, presentation, final report

internship

Test Frequency:

when a course is offered

Module INF-0058: Seminar Algorithms and Data Structures for Masters *Seminar Algorithmen und Datenstrukturen für Master*	4 ECTS/LP
Version 1.5.0 (since SoSe13) Person responsible for module: Prof. Dr. Torben Hagerup	
Learning Outcomes / Competences: Upon completion of the seminar, the students will be able to independently acquire algorithm-related contents from demanding original scientific texts, evaluate the readings in a critical way, and place them in a wider context. They will understand how to select meaningful topics, structure a presentation, focus on the essential messages and communicate them, either in writing or orally, in an interesting and motivating manner, within a given time frame. **Key Qualifications:** Capability of logical, analytical, and conceptual comprehension for a critical analysis of technical issues with convincing arguments; literature research and independent work with English technical literature; ability to evaluate solutions, processes, and techniques from different perspectives; quality awareness; meticulousness; communication skills; time management.	
Workload: Total: 120 h 90 h preparation of written term papers (self-study) 30 h seminar (attendance)	
Conditions: Familiarity with basic algorithms and data structures (as imparted, e.g., by the course "Informatik III") will be highly useful.	

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Algorithms and Data Structures
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current and classical topics from the field of Algorithms and Data Structures are studied, using original literature.

Literature:
Selected scientific articles.

Examination
Written paper and oral presentation.
seminar

Module INF-0059: Project Module Theoretical Computer Science *Projektmodul Theoretische Informatik*	10 ECTS/LP
Version 1.0.0 (since SoSe13) Person responsible for module: Prof. Dr. Torben Hagerup	

Learning Outcomes / Competences:
After successful participation in the project module, the students will be able to understand problems of increased complexity in the field of Theoretical Computer Science. They will possess the skills to develop concepts, methods, procedures, and techniques in research projects, and to apply innovative methods in solving arising problems. In this way, the students acquire good prerequisites for autonomous scientific work and for linking to international research. Furthermore, they will be able to communicate and conduct literature research and have a scientific methodology that enables them to discuss issues of Theoretical Computer Science; they can define intermediate goals, evaluate solution proposals critically and present own approaches.
Key Qualifications:
Logical, analytical, and conceptual competence; quality awareness; meticulousness; independent work; time management; self-contained literature research; work with English technical literature; fundamentals of good scientific practice.

Workload:
Total: 300 h
285 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions:
none

Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Project Module Theoretical Computer Science
Mode of Instruction: internship
Language: German
Contact Hours: 1

Contents:
Collaboration on current research topics.

Literature:
Scientific papers, manuals.

Assigned Courses:

Oberseminar Theoretische Informatik

Examination
Oral presentation and written paper.
internship

Module INF-0072: Project Module Organic Computing *Projektmodul Organic Computing*	10 ECTS/LP
Version 1.0.0 (since SoSe14) Person responsible for module: Prof. Dr. Jörg Hähner	

Learning Outcomes / Competences:
After participating in the project module, the students understand problems of higher complexity in the field of "Organic Computing" and have deeper specialist knowledge and skills in this area. They can develop concepts, methods, procedures, techniques and technologies of the mentioned field in research projects and are able to apply innovative methods in solving problems. This enables them to connect to international research and make their own scientific contribution to the field. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine and present intermediate results and innovative ideas.

Key qualifications: Ability to think logically, analytically and conceptually; Independent work with literature in English. Understandable, confident and convincing presentation of ideas, concepts and results; Quality awareness; Communication skills; Skill of working in teams and understanding team processes; Principles of good scientific practice; Project management skills; Scientific methodology.

Workload:
Total: 300 h
285 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projektmodul Organic Computing
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Collaboration on current research topics.

Literature:
Depending on the topic to be worked on:

- Paper
- Book
- Handbook

Assigned Courses:

Oberseminar Organic Computing

Examination
Presentation and final report.
internship

Module INF-0080: Project Module Databases and Information Systems *Projektmodul Datenbanken und Informationssysteme*	10 ECTS/LP

Version 1.6.0 (since SoSe14)
Person responsible for module: Prof. Dr. Peter Michael Fischer

Learning Outcomes / Competences:
After participating in the project module, students understand problems of higher complexity levels in the field of databases and information systems and have deeper professional knowledge and skills there. They are able to develop concepts, methods, procedures, techniques and technologies of the mentioned field in research projects and are able to apply innovative methods in solving problems. This enables them to connect to international research and make their own scientific contribution to the field. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine and present intermediate results and innovative ideas.
Key Skills: Skill in logical, analytical, and conceptual thinking; Independent work with English-language literature; Intelligible, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill in working in teams and understanding team processes; Principles of good scientific practice; Project management skills; Scientific methodology.

Workload:
Total: 300 h
15 h seminar (attendance)
285 h internship / practical course (self-study)

Conditions:
Module Database Systems (INF-0073) - recommended
Module Search Engines (INF-0077) - recommended
Module Analyzing Massive Data Sets (INF-0277) - recommended

Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projektmodul Datenbanken und Informationssysteme
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Work on current research topics

Literature:
- Current research articles on the topic of databases and Big Data
- Manuals

Assigned Courses:

Oberseminar Datenbanken und Informationssysteme

Examination
Software acceptance, presentation, final report
internship

Module INF-0088: Bayesian Networks *Bayesian Networks*	5 ECTS/LP
Version 1.1.0 (since WS15/16) Person responsible for module: Prof. Dr. Rainer Lienhart	

Learning Outcomes / Competences:
Bayesian networks are one of the most versatile statistical machine learning methods. After successfully completing this module, participants will understand and deepen their understanding of the core principles of Bayesian networks and be able to apply them to many practical problems in a variety of disciplines. These include robotics, web search, intelligent agents, automated diagnostic systems and medical systems. Students will be able to understand and apply Bayesian networks and analyse and evaluate cross-disciplinary problems in this context. Participation in this module promotes logical, analytical and conceptual thinking skills. Students will be able to produce scientifically meaningful evaluations using Bayesian networks.

Key qualifications: advanced mathematical-formal logic; implementation of subject-specific solution concepts in models; interdisciplinary knowledge; development and implementation of solution strategies for complex problems; systematic further development of design methods; ability to solve problems under practical boundary conditions.

Remarks:
INF-0263 and this module **cannot** be attended at the same time.

Workload:
Total: 150 h
15 h studying of course content using provided materials (self-study)
60 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)
30 h exercise course (attendance)
30 h lecture (attendance)

Conditions: none		
Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Bayesian Networks (Vorlesung)
Mode of Instruction: lecture
Language: German
Contact Hours: 2

Contents:

1. Basics of Probability Theory
2. Example: Bayesian Network based Face Detection
3. Inference
4. Influence Diagrams
5. Parameter Learning
6. Example: probabilistic Latent Semantic Analysis (pLSA)

Literature:

- Richard E. Neapolitan. Learning Bayesian Networks. Prentice Hall Series in Artifical Intelligence, 2004. ISBN 0-13-012534-2
- Daphne Koller, Nir Friedman. Probabilistic Graphical Models: Principles and Techniques. The MIT Press, 2009. 978-0262013192

Assigned Courses:

Bayesian Networks (lecture)

Part of the Module: Bayesian Networks (Übung)

Mode of Instruction: exercise course

Language: German

Contact Hours: 2

Assigned Courses:

Übung zu Bayesian Networks (exercise course)

Examination

Bayesian Networks (Examination)

written exam / length of examination: 90 minutes

Test Frequency:

each semester

Description:

The examination can be taken every semester during the examination period.

Module INF-0093: Probabilistic Robotics *Probabilistic Robotics*	5 ECTS/LP
Version 1.0.0 (since SoSe14) Person responsible for module: Prof. Dr. Rainer Lienhart	

Learning Outcomes / Competences:
After successful participation in this module, participants understand basics and in-depth issues and algorithms of robotics (e.g. recursive state estimation, Gaussian and non-parametric filters, Kalman filters, motion and localisation, perception, mapping, SLAM) from a probabilistic point of view and can apply learned concepts to complex, practice-relevant tasks. Students can analyse and evaluate problems in this context. Participation in this module promotes skills in logical, analytical and conceptual thinking in the field of probabilistic robotics. Students can select suitable methods from the concepts learned in a targeted manner, apply them confidently and transfer them to new problems, including those from other disciplines. The module imparts competencies for recognising current research and significant technological developments in this field.

Key qualifications: advanced mathematical-formal logic; implementation of subject-specific solution concepts; interdisciplinary knowledge; development and implementation of solution strategies for complex problems; systematic further development of design methods; ability to solve problems under practical boundary conditions.

Workload:
Total: 150 h
30 h exercise course (attendance)
30 h lecture (attendance)
15 h studying of course content using provided materials (self-study)
60 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)

Conditions: none		
Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Probabilistic Robotics (Lecture)
Mode of Instruction: lecture
Language: German
Contact Hours: 2

Contents:

1. Introduction to Probabilistic Robotics
2. Recursive State Estimation
3. Gaussian Filters
4. Nonparametric Filters
5. Robot Motion
6. Robot Perception
7. Mobile RobotLocalization: Markow and Gaussian
8. Mobile Robot Localization: Grid and MonteCarlo
9. Occupancy Grid Mapping
10. SLAM

Literature:

Sebastian Thrun, Wolfram Burgard, Dieter Fox. Probabilistic Robotics. Springer Verlag.

Part of the Module: Probabilistic Robotics (Tutorial)

Mode of Instruction: exercise course

Language: German

Contact Hours: 2

Examination

Probabilistic Robotics (Examination)

written exam / length of examination: 90 minutes

Test Frequency:

each semester

Description:

The examination can be taken every semester during the examination period.

Module INF-0095: Seminar Multimedia Computing & Computer Vision (MA) *Seminar Multimedia Computing (MA)*	4 ECTS/LP

Version 1.0.0 (since SoSe14)
Person responsible for module: Prof. Dr. Rainer Lienhart

Learning Outcomes / Competences:
After attending the seminar, the students can independently work out and analyse advanced problems, concepts, methods, procedures, techniques, and technologies from the field of multimedia computing and computer vision (e.g. image and video processing, machine learning, and image and video search) and evaluate them in relation to the individual seminar topic.
Participants possess scientific methodology, communication skills, and the ability to present a special topic clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively.
Furthermore, they learn to recognise logical structures of thinking and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a talk that is clear and easy to follow. Additionally, the students know how to focus on essential messages and convey them in a comprehensible way, even with complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to confidently deal with common presentation media and use them interactively. They manage to gear a talk to a specific target group, apply various moderation techniques, and keep their audience engaged even over a longer period.
Key qualifications: Presentation techniques; literature research; principles of good scientific practice; evaluating solution approaches, procedures, techniques, and technologies from different points of view.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Multimedia Computing (MA)
Mode of Instruction: seminar
Language: German
Frequency: each summer semester
Contact Hours: 2

Contents:
The concrete topic of the seminar from the wide-ranging field of multimedia is determined anew each year and adapted to current trends.

Literature:
current research literature

Assigned Courses:

Seminar über Multimedia und Maschinelles Sehen (Master) (seminar)

Examination

Presentation and written paper

seminar

Test Frequency:

when a course is offered

Module INF-0096: Project Module Multimedia Computing *Projektmodul Multimedia Computing*	10 ECTS/LP
Version 1.0.0 (since SoSe14) Person responsible for module: Prof. Dr. Rainer Lienhart	
Learning Outcomes / Competences: After participating in this project module, students understand problems of higher complexity in the field of multimedia computing (e.g. image, video, and audio processing as well as image, video, and audio search) and computer vision (object detection, people detection, human pose estimation) and have more in-depth specialist knowledge and skills there. They can develop concepts, methods, procedures, techniques, and technologies in the mentioned field in research projects and can apply innovative methods in solving problems. This enables them to connect to international research and make their scientific contribution to the field. In addition, students have teamwork and communication skills, the ability to research literature, the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine, and present intermediate results and innovative ideas. **Key qualifications**: Ability to think logically, analytically and conceptually; Independent work with specialist literature; Comprehensible, confident and convincing presentation of ideas, concepts, and results; Quality awareness; Communication skills; Ability to work in teams and understand team processes; Principles of good scientific practise; Project management skills; Scientific methodology.	
Workload: Total: 300 h 285 h internship / practical course (self-study) 15 h seminar (attendance)	
Conditions: none	

Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Project Module Multimedia Computing

Mode of Instruction: internship
Language: German
Frequency: as needed
Contact Hours: 1

Contents:

The specific task from the wide-ranging field of multimedia and machine vision (image, video and audio processing, object recognition, search in image, video and audio material) is designed individually for each student every year.

Literature:

Literature references will be announced at the beginning of the course.

Assigned Courses:

Oberseminar Multimedia Computing

Examination

Software presentation; elaboration with software documentation; explanation of source code (code review)
internship

Module INF-0108: Project Module Teaching Professorship Informatics *Projektmodul Lehrprofessur für Informatik*	10 ECTS/LP

Version 1.0.0 (since SoSe14)
Person responsible for module: Prof. Dr. Robert Lorenz

Learning Outcomes / Competences:
After participating in this project module, students understand problems of higher complexity in the fields of *concurrent systems*, *petri nets* or *process mining* and have more in-depth specialist knowledge and skills there. They can develop concepts, methods, procedures, techniques, and technologies in the mentioned field in research projects and can apply innovative methods in solving problems. This enables them to connect to international research and make their scientific contribution to the field. In addition, students have teamwork and communication skills, the ability to research literature, the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine, and present intermediate results and innovative ideas.

Key qualifications: Ability to think logically, analytically and conceptually; Independent work with specialist literature; Comprehensible, confident and convincing presentation of ideas, concepts, and results; Quality awareness; Communication skills; Ability to work in teams and understand team processes; Principles of good scientific practise; Project management skills; Scientific methodology.

Workload:
Total: 300 h
15 h seminar (attendance)
285 h internship / practical course (self-study)

Conditions: Basic knowledge in the research fields of *concurrent systems*, *petri nets* or *process mining*		
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projektmodul Lehrprofessur für Informatik
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Collaboration on current research topics of the group

Literature:
- J. Desel, W. Reisig, G. Rozenberg: Lectures on Concurrency and Petri Nets, Springer, Lecture Notes in Computer Science 3098, 2004
- Wil M. P. van der Aalst: Process Mining. Data Science in Action. Springer, 2016.

Assigned Courses:

Oberseminar zu Lehrprofessur für Informatik

Examination
Projektmodul Lehrprofessur für Informatik
practical exam

Module INF-0136: Seminar Software- and Systems Engineering (Master) *Seminar Software- und Systems Engineering (Master)*	4 ECTS/LP
Version 1.1.0 (since SoSe14) Person responsible for module: Prof. Dr. Wolfgang Reif	

Learning Outcomes / Competences:

After successful completion of the seminar, students are able to understand, to learn, to analyse and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of software and systems engineering.

They known the scientific methods, communication skills and the ability to use appropriate media to present a specific topic clearly and comprehensibly in speech and writing and to discuss challenging scientific topics from the aforementioned field critically. They will also be able to recognize the logical structures of reasoning and argumentation and use them.

The participants are able to formulate clearly and understandably and to present specialist knowledge freely. They understand how to structure a presentation in a clear and comprehensible way and how to focus the presentation on the core messages and convey them in a comprehensible way even for complex and advanced subjects.

Die Studierenden verstehen es, präsent aufzutreten und souverän mit gängigen Präsentationsmedien umzugehen und diese interaktiv einzusetzen. Sie schaffen es, einen Vortrag auf eine bestimmte Zielgruppe auszurichten und den Zuhörer auch bei längeren Vortragsdauern zu motivieren und verschiedene Moderationstechniken anzuwenden.

The students understand how to present themselves and how to deal confidently with common presentation media. They manage to focus a presentation to a specific target group and to motivate the audience and they have working knowledge of moderation techniques to guide a discussion.

Soft Skills:

- Literature research
- Independently work with English technical literature
- Analytical competence
- Working methodical
- Principles of good scientific practice
- Ability to present (written and oral) ideas, concepts and results in a comprehensible and convincing manner and to document them
- Ability to think logically, abstractly, analytically and conceptually and to argue precisely
- Awareness for quality aspects
- Communication skills
- Time management
- Evaluation of solution approaches, procedures, techniques and technologies from different points of view

Workload:

Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Software- und Systems Engineering (Master)

Mode of Instruction: seminar

Language: German / English

Contact Hours: 2

Contents:

The topics of the seminar deal wtih current trends in Software and Systems Engineering on the level of graduate students. The topics change from year to year and are regulary adapted to reflect new developments.

Literature:

Depends on the concrete topic.

Examination

Seminar Software- und Systems Engineering (Master)

written/oral exam / length of examination: 45 minutes

work period for assignment: 3 months

Test Frequency:

when a course is offered

Module INF-0137: Project Module Software- and Systems Engineering *Projektmodul Software- und Systems Engineering*	10 ECTS/LP

Version 1.1.0 (since SoSe14)
Person responsible for module: Prof. Dr. Wolfgang Reif

Learning Outcomes / Competences:
After participating in the project module, students understand problems of higher complexity from the field of software and systems engineering and have more in-depth knowledge and skills. They are able to develop concepts, methods, techniques and technologies of the mentioned field in research projects and are able to apply innovative methods in solving problems. This enables them to connect to international research and make their own scientific contribution to the field. In addition, students have teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine and present intermediate results and innovative ideas.

Soft Skills:

- Skill in logical, analytical and conceptual thinking.
- Ability to work independently with technical literature, including English literature
- Clear, confident and convincing presentation of ideas, concepts and results
- Awareness for quality aspects
- Communication skills
- Ability to work in teams and understand team processes
- Principles of good scientific practice
- Competencies in project management
- Research methodology

Workload:
Total: 300 h
285 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Project Module Software- and Systems Engineering
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Contribution to current research projects of the chair for Software Engineering

Literature:
Depends on the project: Scientific papers, system documentation, books, ...

Assigned Courses:

Oberseminar Software- und Systems Engineering

Examination

Project Module Software- and Systems Engineering Project Presentation

practical exam / work period for assignment: 2 months

Test Frequency:

when a course is offered

Module INF-0149: Practical Module Embedded Systems *Praktikum Eingebettete Systeme*	5 ECTS/LP
Version 2.2.0 (since SoSe20) Person responsible for module: Prof. Dr. Sebastian Altmeyer	

Learning Outcomes / Competences:
Over the course of the semester, students develop a complete embedded system as a coherent semester assignment. A core task of the course is to analyse the characteristics and recognize the functionality of microcontrollers and peripherals based on data sheets and specifications. The students will have the opportunity to assemble the components needed for an assignment and to define suitable interfaces. Due to the required development and implementation on a microcontroller, the students apply the concepts learned directly in practice. The focus is on the interaction with sensors and actuators as well as on the communication with other parts of the system. To this end, they will identify and apply different types of flow control. During the lab, students learn to plan complex assignments, design solutions and test and evaluate their functionality. The exchange among the students aimed at during the course enables them to appropriately compare and discuss the results achieved.
Students acquire competencies in the following areas at an advanced, practice-oriented, but scientific level: independent work with microcontrollers, data sheets and specifications, interfacing of analog and digital peripherals, design and modelling of embedded software with state charts and their implementation in code. Further focus is on the configuration of sequential interfaces as well as scheduling and task-based programming.
Schlüsselqualifikationen:
Ability to understand and document ideas, concepts and results;
Consciousness of quality, meticulousness;
Project-related work and time management;
selection and correct application of appropriate methods;
ability to expand existing knowledge independently;
Self-reflection

Workload:
Total: 150 h
90 h studying of course content through exercises / case studies (self-study)
60 h internship / practical course (attendance)

Conditions: Knowledge in C-Programming.		
Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Eingebettete Systeme
Mode of Instruction: internship
Language: German / English
Contact Hours: 4

Contents:

The practical course "Embedded Systems" aims to learn the challenges of programming embedded systems. The central platform is a development board that offers a microcontroller as well as various sensors, actuators, displays and interfaces for further peripherals. The programming is done in C without the application of hardware abstraction layers and the created programs are supposed to read out different sensors and set corresponding actuators. In particular, the challenges of embedded systems, such as the timing of the software as well as working with data sheets, are to be learned. Towards the end of the course, the basic knowledge acquired at the beginning will be deepened and already existing sub-components will be assembled into a more complex embedded system.

Literature:

- Zhu, Yifeng: Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, Third Edition, E-Man Press LLC, 2017
- White, Elecia: Making Embedded Systems, O'Reilly Media Inc., 2012
- Marwedel, Wehmeyer: Eingebettete Systeme, Springer Verlag, Heidelberg, 2007

Examination

Praktikum Eingebettete Systeme

practical exam

Module INF-0170: Project Module Human-Centered Multimedia *Projektmodul Human-Centered Multimedia*	10 ECTS/LP

Version 1.0.0 (since SoSe13)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After participating in the project module, students understand problems of higher complexity in the field of "Human-Centered Multimedia" and have deeper expertise and skills there. They are able to develop concepts, methods, procedures, techniques and technologies of the mentioned field in research projects and are able to apply innovative methods in solving problems. This enables them to connect to international research and make their own scientific contribution to the field. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine and present intermediate results and innovative ideas.

Key qualifications: Skill in logical, analytical, and conceptual thinking; Independent work with English-language literature; Intelligible, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill in working in teams and understanding team processes; Principles of good scientific practice; Project management skills; Scientific methodology;

Workload:
Total: 300 h
15 h seminar (attendance)
285 h internship / practical course (self-study)

Conditions:
none

Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Project Module Human-Centered Multimedia
Mode of Instruction: internship
Language: German
Contact Hours: 1

Contents:
Collaborate on current research topics.

Literature:
Literature references will be given at the beginning of the module depending on the topic.

Assigned Courses:

Oberseminar Human-Centered Multimedia

Examination
Project Module Human-Centered Multimedia
practical exam

Module INF-0182: Practical Module Multimodal Real Time Signal Processing *Praktikum Multimodale Echtzeitsignalverarbeitung*	8 ECTS/LP

Version 1.0.0 (since SoSe13)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After successful participation in this module, students are familiar with the basic concepts of signal processing and machine learning. They are able to translate technical solution concepts into programs and models and master the selection and safe application of suitable methods. During the internship, they also learn to plan larger project tasks (development of software modules) in small teams, to solve them according to a self-developed project plan and to discuss the results appropriately in plenary sessions and present them as a team. The ability to evaluate suitable methods in a scientifically meaningful way, to develop the methods and algorithms independently and to implement them technically is also particularly encouraged.

Key qualifications: Advanced knowledge of signal processing and machine learning, skill in analyzing and structuring complex computer science problems, skill in developing and implementing solution strategies for complex problems, understanding of team processes, skill in working in teams, self-reflection; acting responsibly in the face of inadequacy and conflicting interests, quality awareness, meticulousness.

Workload:
Total: 240 h
90 h internship / practical course (attendance)
150 h studying of course content through exercises / case studies (self-study)

Conditions:
Programming experience

Module Foundations of Multimedia I (INF-0087) - recommended
Module Foundations of Multimedia II (INF-0166) - recommended

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Multimodal Real Time Signal Processing
Mode of Instruction: internship
Language: German
Contact Hours: 6

Contents:
The specific task from the wide field of multimodal real-time signal processing is designed every year.

Literature:
Literature references will be announced at the beginning of the semester depending on the topic.

Examination
Practical Module Multimodal Real Time Signal Processing
practical exam

Module INF-0183: Practical Module Game Programming *Praktikum Spieleprogrammierung*	8 ECTS/LP

Version 1.0.0 (since SoSe13)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After successful participation in this module, students understand the essential concepts of game development. They are able to plan larger project tasks in small teams, to solve them according to a self-developed project plan and to discuss and present the results appropriately in plenary sessions. They are able to translate technical solution concepts into programs and models and master the selection and safe application of suitable methods. They have the knowledge of the way of thinking and the language of application-relevant disciplines. During the internship, they learn to evaluate various components of a game in a scientifically meaningful way using suitable methods, to develop the methods and algorithms independently and to implement them technically. The skills of confident and convincing presentation of ideas and concepts, comprehensible presentation and documentation of results as well as logical, analytical and conceptual thinking are also particularly promoted in this context.

Key qualifications: Skill in confident and persuasive presentation of ideas and concepts; knowledge of the thinking and language of application-relevant disciplines; understanding of team processes; skill in working in teams; ability to lead teams; skill in comprehensible presentation and documentation of results; ability to expand existing knowledge independently; ability to contribute to science; competence in recognizing significant technical developments; quality awareness, meticulousness.

Workload:
Total: 240 h
90 h internship / practical course (attendance)
150 h studying of course content through exercises / case studies (self-study)

Conditions:
Module Foundations of Game Programming (INF-0179) - recommended

Frequency: each winter semester	**Recommended Semester:** from 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Game Programming
Mode of Instruction: internship
Language: German
Contact Hours: 6

Contents:
A game is to be developed within the internship. The content focus of the internship is determined each year.

Literature:
References will be announced at the beginning of the semester.

Examination
Practical Module Game Programming
practical exam

Module INF-0217: Practical Module Autonomous Driving *Praktikum Autonomes Fahren*	10 ECTS/LP

Version 2.0.0 (since WS21/22)
Person responsible for module: Prof. Dr. Bernhard Bauer
Prof. Dr. Lars Mikelsons

Learning Outcomes / Competences:
After participating in the practical course on autonomous driving, students will be able to solve practical problems of high complexity in conceptual design, development, and safeguarding of highly automated/autonomous vehicles using current methods and tools of model-based development. The students acquire in-depth subject-specific and interdisciplinary knowledge and skills, for example, from hardware-related computer science, software engineering, and the underlying driving physics and mathematics. They are able to develop concepts, methods, procedures, techniques, and technologies of the mentioned field in research projects and are able to apply innovative approaches in solving problems. This enables them to link up with international research and make their scientific contribution to the field. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the area, define intermediate goals, and critically evaluate, classify, combine, present and document intermediate results and innovative ideas understandably.

Key qualification: Ability to think logically, analytically, and conceptually; Independent work with English-language specialist literature; Understandable, confident, and convincing presentation of ideas, concepts, and results; Quality awareness; Communication skills; Ability to work in teams and understand team processes; Project management skills.

Remarks:
The practical course is offered alternately by the two chairs mentioned above.

Workload:
Total: 300 h
150 h internship / practical course (attendance)
150 h studying of course content through exercises / case studies (self-study)

Conditions:
Participation in one of the two seminars is recommended.

Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 10	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Autonomes Fahren
Mode of Instruction: internship
Language: German / English
Contact Hours: 10

Contents:

In this practical course, the participants learn how various selected partial aspects of autonomous driving can be implemented, simulated, and analyzed.

In addition, the participants will get to know, among other things, development tools frequently used in the automotive environment.

After an introductory course, the participants will implement autonomous driving functions in small groups with the help of the tools mentioned.

The developed results are finally demonstrated and evaluated.

Assigned Courses:

Praktikum über Autonomes Fahren (internship)

Examination

Praktikum Autonomes Fahren

portfolio exam

Test Frequency:

when a course is offered

Module INF-0227: Seminar Database Systems Master *Seminar Datenbanksysteme für Master*	4 ECTS/LP
Version 1.0.0 (since SoSe16) Person responsible for module: Prof. Dr. Peter Michael Fischer	

Learning Outcomes / Competences:
After attending the seminar, students are able to independently develop, analyze and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of database systems in relation to the individual seminar topic from the mentioned field.
They have the scientific methodology, communication skills and ability to use appropriate media to present a specific topic in a clear and understandable manner, both verbally and in writing, and to critically and argumentatively discuss and evaluate scientifically challenging topics from the named field. They will also be able to recognize the logical structures of reasoning and argumentation and use them in a goal-oriented manner.
The participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a lecture in a clear and comprehensible way and how to focus the lecture on essential messages and convey them in a comprehensible way, even in the case of complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions.
The students understand how to present themselves and how to deal confidently with common presentation media and to use them interactively. They manage to gear a lecture to a specific target group and to motivate the listener even during longer lecture durations and to apply various moderation techniques.
Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and for their documentation; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management; Evaluation of approaches, procedures, techniques and technologies from different points of view.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: Module Database Systems (INF-0073) - recommended		
Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Datenbanksysteme für Master
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
Current research contributions from the field of "Databases and Information Systems".

Literature:
Current research contributions

Assigned Courses:

Seminar Datenbanksysteme für Master (seminar)

Examination

lecture and written elaboration

seminar

Module INF-0240: Seminar Information Systems Master *Seminar Informationssysteme für Master*	4 ECTS/LP
Version 1.0.0 (since WS16/17) Person responsible for module: Prof. Dr. Peter Michael Fischer	

Learning Outcomes / Competences:
After attending the seminar, students are able to independently develop, analyze and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of information systems related to the individual seminar topic from the mentioned field.
They have the scientific methodology, communication skills and ability to use appropriate media to present a specific topic in a clear and comprehensible manner, both verbally and in writing, and to critically and argumentatively discuss and evaluate scientifically challenging topics from the named field. They will also be able to recognize the logical structures of reasoning and argumentation and use them in a goal-oriented manner.
The participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a lecture in a clear and comprehensible way and how to focus the lecture on essential messages and convey them in a comprehensible way, even in the case of complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions.
The students understand how to present themselves and how to deal confidently with common presentation media and to use them interactively. They manage to gear a lecture to a specific target group and to motivate the listener even during longer lecture durations and to apply various moderation techniques.
Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and for their documentation; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management; Evaluation of approaches, procedures, techniques and technologies from different points of view.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: Module Database Systems (INF-0073) - recommended		
Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Informationssysteme für Master
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
Current research contributions from the field of "Databases and Information Systems".

Literature:
Current research contributions

Examination

Lecture and written elaboration

seminar

Module INF-0247: Practical Module on Digital Manufacturing *Praktikum für Produktionsinformatik (Vertiefung)*	6 ECTS/LP

Version 1.0.0 (since SoSe17)
Person responsible for module: Prof. Dr.-Ing. Johannes Schilp

Learning Outcomes / Competences:
Students work through the digital product development process in small groups using an industry-related example. They are able to independently analyze engineering tasks and develop solution concepts. The knowledge from the engineering fundamentals is deepened by application examples. You will be able to use selected CAx programs (CATIA V5, PlantSim, FreeCAD) for the development of a product. The practical course provides an introduction to the following topics:
1. CAD design
2. FEM analysis
3. topology optimization
4. production planning
5. mathematical optimization
Key qualifications: Teamwork and communication skills, structured and conscientious work, application-oriented problem solving, result evaluation and
-documentation, weighing of solutions, ability to think logically, analytically and conceptually, ability to think abstractly.

Workload:
Total: 180 h
10 h preparation of presentations (self-study)
40 h preparation of written term papers (self-study)
10 h lecture (attendance)
60 h internship / practical course (attendance)
60 h studying of course content through exercises / case studies (self-study)

Conditions: Grundkenntnisse in CATIA V5 empfehlenswert		
Frequency: each winter semester	**Recommended Semester:**	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum für Produktionsinformatik (Vertiefung)
Mode of Instruction: internship
Language: German
Contact Hours: 4
ECTS Credits: 6.0

Contents:
Students work in small groups on application-oriented tasks on topics in the industrial environment.
The time schedule of this internship will be announced in Digicampus.

Examination
Praktikum für Produktionsinformatik (Vertiefung)
internship

Module INF-0250: Practical Module Reinforcement Learning *Praktikum Reinforcement Learning*	8 ECTS/LP

Version 1.3.0 (since SoSe17)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After successful participation in this module, students understand the essential concepts of reinforcement learning. They are able to plan larger project tasks in small teams, to solve them according to a self-developed project plan and to discuss and present the results appropriately in plenary sessions. You are able to translate technical solution concepts into programs and models and are proficient in the selection and confident application of appropriate methods. They have the knowledge of the way of thinking and the language of application-relevant disciplines. During the internship, they learn to evaluate learning components in a scientifically meaningful way using suitable methods, to develop the methods and algorithms independently and to implement them technically. The skills of confident and convincing presentation of ideas and concepts, comprehensible presentation and documentation of results, as well as logical, analytical and conceptual thinking are also particularly promoted in this context.

Key qualifications: Skill in confident and persuasive presentation of ideas and concepts; knowledge of the thinking and language of application-relevant disciplines; understanding of team processes; skill in working in teams; ability to lead teams; skill in comprehensible presentation and documentation of results; ability to expand existing knowledge independently; ability to contribute to science; competence in recognizing significant technical developments; quality awareness, meticulousness.

Workload:
Total: 240 h
150 h studying of course content through exercises / case studies (self-study)
90 h internship / practical course (attendance)

Conditions: Programming experience		
Frequency: irregular	**Recommended Semester:** from 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Reinforcement Learning
Mode of Instruction: internship
Language: German
Contact Hours: 6

Contents:
The specific task from the field of "reinforcement learning" is designed anew each semester.

Examination
Practical Module Reinforcement Learning
practical exam
Description:
Exception summer term 2020: practical exam

Module INF-0251: Seminar Artificial Intelligence *Seminar Artificial Intelligence*	4 ECTS/LP
Version 1.0.0 (since SoSe17) Person responsible for module: PD Dr. Jonghwa Kim	
Contents: The seminar will take place as a block seminar at the end of June for summer term or mid-December for winter term. The topic area for this seminar will be redefined annually, taking into account new trends in "Artificial Intelligence and Intelligent Systems".	
Learning Outcomes / Competences: After attending the seminar, students are able to independently develop, analyze and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of "Artificial Intelligence and Intelligent Systems" in relation to the individual seminar topic from the mentioned field. They have the scientific methodology, communication skills and ability to use appropriate media to present a specific topic clearly and comprehensibly, both verbally and in writing, and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. They will also be able to recognize the logical structures of reasoning and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a lecture in a clear and comprehensible way and how to focus the lecture on essential messages and convey them in a comprehensible way, even in the case of complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and how to deal confidently with common presentation media and to use them interactively. They manage to gear a lecture to a specific target group and to motivate the listener even during longer lecture durations and to apply various moderation techniques. **Key qualifications:** Evaluation of approaches, procedures, techniques and technologies from different points of view; literature research; independent work with English-language technical literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and in documenting them; skill in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management.	
Workload: Total: 120 h 30 h seminar (attendance) 90 h preparation of written term papers (self-study)	
Conditions: none	**Credit Requirements:** Passing the module exam

Frequency: usu. at least once per acad. year	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Artificial Intelligence
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 4.0

Contents:

The seminar will take place as a block seminar at the end of June for summer term or mid-December for winter term. The topic area for this seminar will be redefined annually, taking into account new trends in "Artificial Intelligence and Intelligent Systems".

Literature:

current research literature

Examination

Seminar Artificial Intelligence

written/oral exam

Module INF-0272: Intelligent Signal Analysis in Medicine *Intelligente Signalanalyse in der Medizin*	5 ECTS/LP

Version 1.1.0 (since WS17/18)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:

Knowledge: The students learn the principal concepts of sequential signal processing, signal source separation, and feature extraction and information reduction exemplified by medically relevant audio and bio signals. They further gain insight into machine learning principles such as learning dynamics and context as is needed for many intelligent signal analysis tasks. They will learn about different problems and solutions in the analysis of a variety of signals relevant in the context of health care, wellbeing, and general medical signals analysis. Students will get to know the mindset of modern machine learning, computer-aided health care, and get to know ethical implications.

Skills: The students will be able to choose appropriate algorithms of signal processing and machine intelligence, further develop these, design new solutions, and apply these to a broad range of medical signal analysis problems. They will practice to think logically and conceptionally in order to select appropriate solutions to a given task. Students will be able to recognise important technical developments in the field of signal processing, machine learning and e-Health/m-Health.

Competences: The students are able to characterise, judge on the quality and suitability, and design suited algorithmic solutions for intelligent signal analysis with a focus on medical signals. They are further able to realise the learnt concepts in programs and machine learning models. Participants will be able to analyse and structure complex and practice-oriented problems in the field of m-Health and e-Health and to find suitable and state-of-the-art solutions. They know how to make scientifically meaningful evaluations of proposed systems. They will further learn how to document and present results in a reasonable and meaningful way.

Key skills: Formal methods; Knowledge of advantages and disadvantages of different design alternatives; Systematical advancement of design tools; Ability to work in teams; Knowledge of workflows and processes; Ability to find solutions for practical problems; Ability to work autonomously; Quality awareness; Scientific working; Literature research.

Workload:
Total: 150 h
30 h exercise course (attendance)
30 h lecture (attendance)
60 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)
15 h studying of course content using provided materials (self-study)

Conditions:	**Credit Requirements:**
Knowledge of basic mathematic lectures should be present.	Bestehen der Modulprüfung

Frequency: irregular	**Recommended Semester:**	**Minimal Duration of the Module:**
	from 1.	1 semester[s]
Contact Hours:	**Repeat Exams Permitted:**	
4	according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Intelligente Signalanalyse in der Medizin (Vorlesung)
Mode of Instruction: lecture
Language: English
Contact Hours: 2

Contents:

Topics: Basics of Signal Processing, Signal Source Separation, Data Acquisition and Annotation, Audio-Visual Feature Extraction, Machine Learning, e-Health, m-Health, Ethics, Python, Machine Learning Toolkits.

Literature:

Björn Schuller: "*Intelligent Audio Analysis",* Signals and Communication Technology, Springer, ISBN: 978-3642368059, 2013.

Part of the Module: Intelligente Signalanalyse in der Medizin (Übung)

Mode of Instruction: exercise course

Language: English

Frequency: irregular (usu. summer semester)

Contact Hours: 2

Examination

Intelligente Signalanalyse in der Medizin

written exam / length of examination: 90 minutes

Module INF-0273: Practical Module Sensing for Fitness and Wellbeing *Praktikum Mobile Sensing for Fitness and Wellbeing*	5 ECTS/LP

Version 1.0.0 (since WS17/18)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
Students learn to realise concepts and models of sensing health- and fitness-related parameters on smart devices. They learn how to acquire signals from different modalities and sensors and to implement algorithms of pattern recognition on mobile devices. After participation in the Praktikum, students know how to analyse and structure complex problems in the field and to select suitable and state-of-the-art approaches to their solution.

Participants are trained in their analytical and conceptional skills as well as in practical programming skills to transfer their knowledge to a practical task. They learn how to make scientifically meaningful assessments of their system using appropriate methods. They will know the mindset of two different fields, software development and machine learning. All knowledged obtained during the Praktikum is applied in practice-oriented tasks. Furthermore, after participation, students will be able to recognise important technical evolution in the field of sensors, mobile apps and related tools, and intelligent signal analysis.

Students will work in teams and organise their work and task distribution in an autonomous way. They will learn how to summarise, present and document results in a reasonable way

Key skills: Formal methods; Methods for software development and abstraction; Versioning tools; Knowledge of advantages and disadvantages of different design alternatives; Systematical advancement of design tools; Ability to work in teams, Understanding of team management; Knowledge of workflows and processes; Ability to find solutions for practical problems; Ability to work autonomously; Quality Awareness.

Workload:
Total: 150 h
60 h internship / practical course (attendance)
90 h studying of course content through exercises / case studies (self-study)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Sensing for Fitness and Wellbeing
Mode of Instruction: internship
Language: English
Frequency: each winter semester
Contact Hours: 4

Contents:

Research in the field of m-Health is focussed on the design and development of sensors, systems, and applications to recognise, interpret and simulate human states w.r.t. fitness, health, and wellbeing.
In this Praktikum, students will experience in designing relevant systems, which are using modalities originating from different sensors, such as, vital signs, audio, speech, and video. In small teams, they will implement and evaluate an application running on a smart device.

Literature:

To be announced by the lecturer

Examination

Practical Module Sensing for Fitness and Wellbeing

practical exam

Module INF-0274: Seminar Embedded Intelligence for Health Care and Wellbeing (Master) *Seminar Embedded Intelligence for Health Care and Wellbeing (Master)*	4 ECTS/LP

Version 1.0.0 (since WS17/18)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
After attending the seminar, students will be able to autonomously acquire and understand advanced problem statements, concepts, methods, approaches, techniques, and technologies in the field of Embedded Intelligence for Health Care and Wellbeing. They possess the scientific techniques, communication skills, and the ability to employ suitable media, to present understandingly a special topic in spoken and written, and to discuss and evaluate scientifically challenging themes from the field in a critical way. Furthermore, they can recognise logical structures of thinking and debating and employ them constructively.
Participants can express themselves in a clear and understandable way and present scientific topics. They understand how to structure a talk, to focus it - also given a complex content - on the essential messages, and to communicate them in a suitable way. The lines of arguments and strategies in case of disturbances are applied by the students. Students know how to perform energetically, to cope with the presentation media and to use them interactively. They manage to orient a talk toward a certain audience, to motivate the listeners also over a longer duration, and to employ different methods of moderation.

Key skills: Fundamentals of good scientific practice; Analytical-methodological competency; Time management; Literature research; Self-contained work with English technical literature; Communication skills; Ability to present (in written and spoken) practical and theoretical ideas in an understandable, confident, and convincing way; Writing a report in the markup language LaTeX; Evaluation of methods, technologies, and solutions w.r.t. different aspects; Quality awareness.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: irregular	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Embedded Intelligence for Health Care and Wellbeing (Master)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:

In the seminar Embedded Intelligence for Health Care and Wellbeing, recent research works in this field are going to be discussed. This comprises both the acquisition of data through sensors and (e.g., microphones or electrodes) and the analysis and the modelling of the data. One important aspect is also the practicability of modern deep learning methods. Health Care and Wellbeing applications reach from tracking of health states (e.g., epilepsy or depression) to personal assistance services.

The participating students will work on a certain aspect, supervised by a research associate of the chair. They will summarise their results in a written report and an oral presentation.

Topics: E-Health, M-Health, Sensor Signal Analysis, Vital Signs, Big Data.

Literature:

Wird vom Dozenten oder der Dozentin bekannt gegeben

Examination

Seminar Embedded Intelligence for Health Care and Wellbeing (Master)

written/oral exam

Module INF-0275: Project Module Embedded Intelligence for Health Care and Wellbeing *Projektmodul Embedded Intelligence for Health Care and Wellbeing*	10 ECTS/LP

Version 1.1.0 (since WS17/18)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
After participating in the project module, the students understand problems of higher complexity in the field of embedded systems and intelligent signal analysis, especially for applications in medical and sports informatics, and have in-depth specialist knowledge and skills there. They can develop concepts, methods, procedures, techniques and technologies in the area mentioned in research projects and are able to apply innovative methods to solve problems. This enables them to tie in with international research and make their own scientific contribution in this field. In addition, the students have the team and communication skills, the ability to research literature and the scientific methodology to discuss problems in the field, to define intermediate goals, as well as to critically evaluate, classify, combine and present intermediate results and innovative ideas.

Key Qualifications: Ability to think logically, analytically and conceptually; Independent work with English-language specialist literature; understandable and convincing presentation of ideas, concepts and results; quality awareness; communication skills; team collaboration skills and understanding of team processes; principles of good scientific practice; project management skills; scientific methodology; software development and testing.

Workload:
Total: 300 h
285 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projektmodul Embedded Intelligence for Health Care and Wellbeing
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Autonomous collaboration on current research topics.

Literature:
Scientific publications; manuals; is provided by the chair.

Assigned Courses:

Oberseminar Embedded Intelligence for Health Care and Wellbeing

Examination
Projektmodul Embedded Intelligence for Health Care and Wellbeing
practical exam

Module INF-0277: Analyzing Massive Data Sets

Analyzing Massive Data Sets

8 ECTS/LP

Version 1.2.0 (since SoSe18)
Person responsible for module: Prof. Dr. Peter Michael Fischer

Learning Outcomes / Competences:
After attending the course, students will be able to understand and evaluate the concepts and methods, procedures, techniques, and technologies for analyzing massively large data sets. Possible content includes:

- Fundamentals of information retrieval
- Similarity search and clustering
- Analysis of data streams and temporal data
- Web graphs: Link analysis and social networks
- Dynamic networks and information diffusion
- Recommender systems and online advertising
- Computational methods for massive data sets

Students will also be able to implement technical solution concepts for analyzing large data sets in programs.
Key Skills: Ability to think logically, analytically and conceptually, weigh up approaches to solutions, acquire abstraction skills; subject-specific in-depth knowledge; implement subject-specific solution concepts in programs and models; knowledge of the advantages/disadvantages of design alternatives and evaluation in the respective application context; selection and confident application of suitable methods; ability to make scientifically meaningful evaluations using suitable methods; ability to solve problems under practical boundary conditions; competence in recognizing significant technical developments;

Workload:
Total: 240 h
30 h studying of course content using literarture (self-study)
90 h studying of course content through exercises / case studies (self-study)
30 h studying of course content using provided materials (self-study)
60 h lecture (attendance)
30 h exercise course (attendance)

Conditions:
Module Database Systems (INF-0073) - recommended
Module Discrete structures for computer science (INF-0109) - recommended
Module Computer Science 3 (INF-0111) - recommended

Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Analyzing Massive Data Sets (Vorlesung)
Mode of Instruction: lecture
Language: English
Contact Hours: 4

Contents:
The lecture covers basic concepts for the analysis of massively large data sets such as information extraction, similarity search, clustering, link and network analysis as well as their implementation.

Literature:

- Mining of Massive Datasets. J. Leskovec, A. Rajaraman, J.D. Ullman. Cambridge UniversityPress, 2014
- D. Easley, J. Kleinberg.Networks, Crowds, and Markets: Reasoning About a Highly Connected World.Cambridge University Press, 2010.
- R. Baeza-Yates, B. Ribeiro-Neto: Modern Information Retrieval

Weitere Literatur wird in der Vorlesung bekannt gegeben

Assigned Courses:

Analyzing Massive Data Sets (lecture)

Part of the Module: Analyzing Massive Data Sets (Übung)

Mode of Instruction: exercise course
Language: English / German
Contact Hours: 2

Assigned Courses:

Übung zu Analyzing Massive Data Sets (exercise course)

Examination

Analyzing Massive Data Sets

written exam / length of examination: 90 minutes

Module INF-0279: Music Informatics *Music Informatics*	5 ECTS/LP
Version 1.3.0 (since SoSe18) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:

Knowledge: The course Music Informatics presents the fundamental concepts of music theory and the music language and its representation in the visual, symbolic, and acoustic domain. Several digital formats for music symbolic representation, such as Music XML, MEI, Kern**, and MIDI protocol, as well as open source tools such as LilyPond and Csound will be introduced. Machine learning principles and techniques with applications in music information retrieval and computational musicology will be practically applied. Students will learn about different problems and solutions in the analysis of symbolic and acoustic music data. Students will get to know the mindset from both sides, the musicological and the computer scientist perspective.

Skills: The students will understand the basic principles of music theory and its representation in digital language, being able to analyse, interpret, and create musical samples in a variety of symbolic formats and programming languages. They will learn to apply machine learning procedures, such as feature extraction and pattern recognition, to music information retrieval problems, such as key detection and music-score synchronisation, amongst other. After participation, students will know how to advance existing concepts and approaches in the field of music informatics and data analysis. Furthermore, they will be able to recognise important technical developments in the field of data science and signal processing.

Competences: By integrating basic principles of music theory, its representation in digital language, and machine learning techniques, the students will be able to identify new problems and solutions in the field of music information retrieval considering a variety of musical styles and genres. The students are able to characterise, judge on the quality and suitability, and design suited algorithmic solutions for music data analysis in both the symbolic and the audio domain.
Participants will be able to analyse and structure complex and practice-oriented problems in the field of music informatics and to find suitable solutions, by using state-of-the-art tools and complementary methods, if needed. They know how to make scientifically meaningful evaluations of proposed systems. They will further learn how to document and present results in a reasonable and meaningful way.

Key skills: Computational musicology, Music theory, Digital Music Representation, Basics of Signal Processing, Machine Learning, Music Information Retrieval, Knowledge of advantages and disadvantages of different design alternatives; Systematical advancement of design tools; Ability to work in teams; Knowledge of workflows and processes; Ability to find solutions for practical problems; Ability to work autonomously; Quality awareness; Scientific working; Literature research.

Workload:
Total: 150 h
15 h studying of course content using provided materials (self-study)
60 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)
30 h exercise course (attendance)
30 h lecture (attendance)

Conditions:	**Credit Requirements:**
Knowledge of basic mathematic lectures should be present	Bestehen der Modulprüfung

Frequency: irregular	**Recommended Semester:**	**Minimal Duration of the Module:**
	from 1.	1 semester[s]

Contact Hours:	Repeat Exams Permitted:	
4	according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Music Informatics (Lecture)
Mode of Instruction: lecture
Language: English
Frequency: each summer semester
Contact Hours: 2

Contents:

In Music Informatics, the basic principles of music theory will be presented from both the traditional and computational point of view. Music will be evaluated in three domains: visual, symbolic, and acoustic; and for each of them: formats, programming languages, and machine learning tools will be studied. This course will give a basic introduction to music information retrieval and computational musicology by identify problems and solutions for different kinds of musical genres and styles.

Literature:

- Meinard Müller: *"Fundamentals of Music Processing: Audio, Analysis, Algorithms,* Applications." Springer, ISBN: 978-3-319-21944-8. 2015.
- Björn Schuller: *"Intelligent Audio Analysis",* Signals and Communication Technology, Springer, ISBN: 978-3642368059, 2013.

Part of the Module: Music Informatics (Tutorial)
Mode of Instruction: exercise course
Language: English
Frequency: each summer semester
Contact Hours: 2

Examination
Music Informatics

written exam / length of examination: 90 minutes

Module INF-0284: Practical Module Mobile Application Development *Praktikum Mobile Application Development*	5 ECTS/LP

Version 1.0.0 (since SoSe18)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
Students learn to realise concepts and models of mobile application development on the Android platform. They learn how to acquire data and signals from different sensors and to implement algorithms of pattern recognition and data/ signal analysis on mobile devices. After participation in the Praktikum, students know how to analyse and structure complex problems in the field and to select suitable and state-of-the-art approaches to their solution.

Participants are trained in their analytical and conceptional skills as well as in practical programming skills to transfer their knowledge to a practical task. They learn how to make scientifically meaningful assessments of their system using appropriate methods. They will know the mindset and thinking of application development and software engineering. All knowledged obtained during the Praktikum is applied in practice-oriented tasks. Furthermore, after participation, students will be able to recognise important technical evolution in the field of sensors, mobile apps and related tools, and smart devices.

Students will work in teams and organise their work and task distribution in an autonomous way. They will learn how to summarise, present and document results in a reasonable way.

Key skills: Formal methods; Methods for software development and abstraction; Versioning tools; Knowledge of advantages and disadvantages of different design alternatives; Systematical advancement of design tools; Ability to work in teams, Understanding of team management; Knowledge of workflows and processes; Ability to find solutions for practical problems; Ability to work autonomously; Quality Awareness.

Workload:
Total: 150 h
60 h internship / practical course (attendance)
90 h studying of course content through exercises / case studies (self-study)

Conditions:	**Credit Requirements:**
Programming skills in Java are required.	Bestehen der Modulprüfung

Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Mobile Application Development
Mode of Instruction: internship
Language: English
Contact Hours: 4

Contents:

In the Praktikum Mobile Application Development, students will develop software for the Android platform in groups of 2-4 students.

Students will get to know and to program several groups of Android devices, e.g., mobiles and wearables, and respective sensors. They will familiarise with the Android Studio IDE, the according toolchain and the code management tool Gi.

Topics: Java, Android, App development, UI design, Audio Player, Map and Location, Camera control, Mobile devices, Intelligent signal processing, Wearables.

Literature:

The literature is going to be announced by the lecturers during the course.

Examination

Praktikum Mobile Application Development

practical exam

Module INF-0291: Practical Module Self-Learning Systems *Praktikum Selbstlernende Systeme*	8 ECTS/LP
Version 1.2.0 (since WS18/19) Person responsible for module: Prof. Dr. Jörg Hähner	

Learning Outcomes / Competences:
After participating in the practical course, the students are able to understand and solve problems (of higher complexity) in the field of "machine learning methods". They can compare and classify different methods and apply them independently to concrete examples from practice. Students can evaluate intelligent systems in terms of the algorithmic solution and are further familiar with procedures for evaluating the performance of an intelligent system. They are also able to plan larger project tasks (development of software modules) in small teams, to solve them according to a self-developed project plan and to discuss the results appropriately in the plenum and present them as a team. Furthermore, they can recognise and classify significant technical developments in the field of "machine learning".

Key qualifications:

- Skill in analysing and structuring complex computer science problems, skills in developing and implementing solution strategies.
- Competence to combine different subject areas
- Presentation and documentation of (own) results
- Analytical methodical competence
- Ability to work productively and purposefully in a team
- Meticulous work
- Interdisciplinary knowledge
- Systematic further development of design models
- Time management skills
- Independent literature research on related topics
- Principles of good scientific practice

Workload:
Total: 240 h
225 h internship / practical course (self-study)
15 h (attendance)

Conditions:	**Credit Requirements:**
Recommended: Module Organic Computing II (INF-0066), programming experience, ability to work in a team Module Organic Computing II (INF-0066) - recommended	Passing the module exam

Frequency: each semester	**Recommended Semester:**	**Minimal Duration of the Module:**
	from 2.	1 semester[s]
Contact Hours:	**Repeat Exams Permitted:**	
2	according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Selbstlernende Systeme
Mode of Instruction: internship
Lecturers: Prof. Dr. Jörg Hähner
Language: German
Contact Hours: 2
ECTS Credits: 8.0

Contents:

In the practical module Self-Learning Systems, students learn about different methods from the field of machine learning and, above all, implement them themselves. The necessary theoretical foundations are laid in an introductory course and then applied in small groups to concrete practical examples.

Literature:

current scientific papers

Assigned Courses:

Praktikum zu Selbstlernende Systeme (internship)

Examination

Praktikum Selbstlernende Systeme

portfolio exam, combination of practical and written-oral exam

Description:

written submission, software acceptance, final presentation

Module INF-0293: Advanced Deep Learning *Advanced Deep Learning*	8 ECTS/LP
Version 1.0.0 (since WS18/19) Person responsible for module: Prof. Dr. Rainer Lienhart	

Learning Outcomes / Competences:
After participating in the practical module, students have detailed and up-to-date knowledge in the field of machine learning, can identify significant technical developments and can implement a complete pipeline for multimodal data processing with deep neural networks. They can precisely describe and discuss problems and results in the field and apply learned concepts and methods to similar problems in machine learning. In addition, the students analyse advanced concepts, methods, procedures, techniques and technologies from the field of machine learning to apply them in research projects, transfer them to current industry-related tasks and actively participate in them. The students learn to transfer scientifically challenging topics in the field of machine learning to other research questions and, building on this, to work out a complex project in group work. They also have the teamwork and communication skills to discuss problems in the field, to discuss, describe and present questions and interim results. In addition, students can conduct detailed experiments and assess, compare and check results for plausibility.
Key qualifications:

Advanced mathematical-formal methodology; Translating subject-specific solution concepts into programs and models; Methods for developing larger software systems, construction of abstractions and architectures; Interdisciplinary knowledge; Systematic further development of design methods; Skill of confident and convincing presentation of ideas and concepts; Understanding of team processes; Skill of working in teams; Ability to lead teams; Familiarity with procedures and processes in the application environment of computer science; Skill of solving problems under practical boundary conditions; Self-reflection; Responsible action against the background of inadequacy and conflicting interests; Ability to expand existing knowledge independently; Quality awareness, meticulousness

Workload:
Total: 240 h
30 h studying of course content using provided materials (self-study)
30 h studying of course content using literarture (self-study)
120 h studying of course content through exercises / case studies (self-study)
20 h lecture (attendance)
40 h exercise course (attendance)

Conditions:	**Credit Requirements:**
Fundamental knowledge in computer vision (basic studies lectures "Multimedia Grundlagen 1", "Grundlagen der Signalverarbeitung und des Maschinellen Lernens", "Multimedia Grundlagen 2" as well as master's lectures "Multimedia 2" and "Machine Learning and Computer Vision")	Passing the portfolio examination

Frequency: each winter semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Advanced Deep Learning (Lecture)
Mode of Instruction: lecture
Language: German
Contact Hours: 2

Contents:

- Deep Learning in general
- Deep Convolutional Neural Networks
- Transfer Learning
- Recurrent Neural Networks / LSTM Networks
- Natural Language Processing
- Multimodal Fusion (Vision+Language)
- Application: Image Captioning

Part of the Module: Advanced Deep Learning (Tutorial)

Mode of Instruction: exercise course

Language: German

Contact Hours: 4

Examination

Advanced Deep Learning

portfolio exam, The final grade is made up of assessed exercise sheets and an assessed team project.

Test Frequency:

when a course is offered

Module INF-0294: Speech Pathology *Speech Pathology*	5 ECTS/LP
Version 1.1.0 (since WS18/19) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:

Knowledge: The students learn concepts relating to signal processing, speech production, phonetics, speech and language pathology, speech analysis, feature extraction, denoising and information reduction as exemplified through the analysis of automated voice pathology detection. They further gain insight into machine learning principles, with a particular focus on deep learning solutions, as is needed to diagnose a range of different voice pathologies. They will learn about different problems and solutions in the analysis of a variety of speech, relevant in the context of health care and wellbeing.

Skills: The students will be able to choose appropriate algorithms of signal processing and machine intelligence, further develop these, design new solutions, and apply these to the task of voice pathology detection. They will know how to analyse and structure complex problems in the field, to employ suitable approaches to solve them, and to transfer knowledge to similar tasks. After participation in the course, they will be able to implement approaches and models into programs. Students will be able to assess developed systems in a scientific way. Important technical evolution and novelties in the fields of speech analysis and medical machine learning will be recognised by them.

Competences: The students are able to characterise, judge on the quality and suitability, and design suited algorithmic solutions for intelligent signal analysis with a focus on voice pathology detection. They are further able to present and document results in a reasonable and meaningful way.

Key skills: Formal methods; Knowledge of advantages and disadvantages of different design alternatives; Systematical advancement of design tools; Ability to work in teams; Knowledge of workflows and processes; Ability to find solutions for practical problems; Ability to work autonomously; Quality awareness; Scientific working; Literature research.

Workload:
Total: 150 h
60 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)
15 h studying of course content using provided materials (self-study)
30 h exercise course (attendance)
30 h lecture (attendance)

Conditions: Knowledge of basic mathematic lectures should be present.		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Speech Pathology (Vorlesung)
Mode of Instruction: lecture
Language: English
Frequency: each winter semester
Contact Hours: 2

Contents:

The course "Pathological Speech" will give an introduction to models of speech production (e.g., source-filter models) with a focus on aspects that are relevant to pathologies and their recognition using automated methods of signal processing and machine learning. Moreover, students learn about robust feature extraction, modern methods of machine learning and machine intelligence, and implementation of such systems on devices

Topics: Speech production; Phonetics; Speech and language pathology; Signal processing; Natural language processing; Speech analysis; Feature extraction; Machine learning; Deep learning; Denoising; Information reduction; Healthcare.

Literature:

- Björn Schuller, Anton Batliner: "Computational Paralinguistics: Emotion, Affect and Personality in Speech and Language Processing", Wiley, ISBN: 978-1119971368, 2013.
- Further literature is going to be announced during the lecture.

Part of the Module: Speech Pathology (Übung)

Mode of Instruction: exercise course

Language: English

Frequency: each winter semester

Contact Hours: 2

Examination

Speech Pathology

written exam / length of examination: 90 minutes

Module INF-0296: Practical Module Interactive Machine Learning *Praktikum Interactive Machine Learning*	8 ECTS/LP

Version 1.0.0 (since WS18/19)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After successful participation in this module, students are familiar with basic concepts of interactive machine learning. They are able to translate domain-specific solution concepts into models and master the selection and safe application of suitable methods. In addition, they will gain an insight into current work in the research area. Furthermore, competencies in the areas of teamwork and communication skills as well as self-organization are taught through the processing of project tasks and their independent project planning. In the context of these project tasks, knowledge of the mindset and language of the research field is fostered through the discussion and presentation of project results.

Key qualifications: Conversion of technical solution concepts into programs and models; subject-specific consolidation; interdisciplinary knowledge; ability to make scientifically meaningful evaluations using suitable methods; knowledge of the mindset and language of application-relevant disciplines; ability to work in teams; knowledge of practice-relevant tasks; familiarity with procedures and processes in the application environment of computer science; ability to present and document results in a comprehensible manner; ability to expand existing knowledge independently; competence in recognizing significant technical developments.

Workload:
Total: 240 h
90 h internship / practical course (attendance)
150 h studying of course content through exercises / case studies (self-study)

Conditions: Programming experience		
Frequency: each winter semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Interactive Machine Learning
Mode of Instruction: internship
Language: German
Contact Hours: 6

Examination
Practical Module Interactive Machine Learning
practical exam

Module INF-0297: Practical Module Processor Design *Praktikum Prozessorbau*	5 ECTS/LP

Version 2.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Sebastian Altmeyer
Dr. Martin Frieb

Learning Outcomes / Competences:
Students acquire competencies in the following areas at an advanced, practical but scientific level: design process for digital circuits, circuit logic and gates, physical principles of electronic components, description of hardware with a hardware description language.

First, students learn how to link logic gates and build a half-adder and a full-adder. They understand the digital circuit design process and apply it directly in a practical way by designing their own RISC-V processor. They model and implement it independently using the hardware description language VHDL. To do this, they learn the advantages and disadvantages of schematic and textual hardware description and can decide when it makes sense to use which variant. Furthermore, they combine synchronous and asynchronous processes to achieve a good interaction of the components of their self-built microprocessor. Finally, students evaluate the efficiency of their implementation based on the clock frequency achieved and the hardware effort required. In a final project phase, they learn to plan a complex task, to solve it according to a self-developed sound project plan and to discuss and present the results appropriately in a plenary session.

Key qualifications: Skill in presenting and documenting ideas, concepts and results in a comprehensible manner; quality awareness, meticulousness; project-bound work and time management; selection and confident use of appropriate methods; ability to expand existing knowledge independently; self-reflection.

Workload:
Total: 150 h
90 h studying of course content through exercises / case studies (self-study)
60 h internship / practical course (attendance)

Conditions:
Module Foundations of Technical Computer Science (INF-0138) - recommended
Module Processor Architecture (INF-0147) - recommended

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Prozessorbau
Mode of Instruction: internship
Language: German / English
Contact Hours: 4

Contents:

The course "Processor Design" presents methods of logical design of digital circuits, starting with the abstract description in a hardware description language (such as VHDL) up to the physical implementation on transistor level. In the practical part of the course, hardware design is illustrated using the example of a five-stage processor pipeline. The result is an executable processor developed in VHDL for an FPGA prototype board.

Literature:

- Uwe Brinkschulte, Theo Ungerer, Mikrocontroller und Mikroprozessoren, Springer Verlag, Heidelberg, dritte Auflage 2010
- John L. Hennessy, David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann, 5. Auflage, 2011

Examination

Praktikum Prozessorbau

practical exam

Module INF-0307: Model-Based Development and Analysis of Software Systems *Modellbasierte Entwicklung und Analyse von Software Systemen*	6 ECTS/LP
Version 1.1.0 (since SoSe19) Person responsible for module: Prof. Dr. Bernhard Bauer	

Learning Outcomes / Competences:

Model-based development and analysis of software systems deal with increasing software production efficiency through automation and reuse. In the course, participants learn to apply and compare methods for the model-driven development of software systems. They develop in-depth, subject-specific solution concepts for MDSD. They can evaluate current technologies and standards for MDSD and analyze their applicability in practice-relevant tasks. The participants build up skills for analyzing and structuring complex IT problems in the generation of infrastructure code, subsystems, configurations, or entire applications from models. In doing so, they develop logical, analytical, and conceptual thinking skills and can systematically develop and assess solutions to problems.

Key qualification: Interdisciplinary knowledge; competence in networking different subject areas; teamwork and communication skills; ability to expand existing knowledge independently; quality awareness; familiarity with procedures and processes in the application environment of computer science; knowing and understanding formal quantitative principles; ability to present and document results in an understandable way.

Workload:

Total: 180 h
23 h studying of course content using literarture (self-study)
22 h studying of course content using provided materials (self-study)
30 h exercise course (attendance)
45 h lecture (attendance)
60 h studying of course content through exercises / case studies (self-study)

Conditions: Due to overlaps, the previous course "Model-Driven Software Development" must not have been taken.		
Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 5	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Modellbasierte Entwicklung und Analyse von Software Systemen (Vorlesung)
Mode of Instruction: lecture
Language: German
Contact Hours: 3

Contents:

Model-based development and analysis of software systems are concerned with increasing software production efficiency through automation and reuse. Infrastructure code, subsystems, configurations, or entire applications are generated from models.

Literature:

- slides
- Pohl et al. Software Product Line Engineering: Foundations, Principles, and Techniques
- Kleppe et al: MDA explained
- Hitz et al: UML@Work
- Further literature in the lecture

Part of the Module: Modellbasierte Entwicklung und Analyse von Software Systemen (Übung)
Mode of Instruction: exercise course
Language: German
Contact Hours: 2

Examination
Modellbasierte Entwicklung und Analyse von Software Systemen
oral exam / length of examination: 30 minutes
Test Frequency:
when a course is offered

Module INF-0308: Software-intensive Systems *Software-intensive Systeme*	6 ECTS/LP
Version 1.2.0 (since SoSe19) Person responsible for module: Prof. Dr. Bernhard Bauer	

Learning Outcomes / Competences:

Students can create (K3), evaluate (K6), and document software architectures. For this purpose, they can transfer technical solution concepts into models and know methods for developing such abstractions and architectures. They can describe the advantages and disadvantages of design alternatives (K4) and evaluate them in the respective application context (K6). Problems can be identified independently (K4), and solutions can be designed systematically (K5) and realized (K3). Furthermore, they have developed skills for the analysis and structuring of problems in enterprise architectures and know the concepts and procedures for creating such architectures. The students can name practice-relevant issues in enterprise architectures (K1). They can select and confidently apply suitable methods for architecture creation and evaluation. The students know modeling languages and patterns to create software and enterprise architectures. They have the competence to recognize significant technical developments.

Key qualification: Competence to network different subject areas; ability to work in a team and communicate; ability to expand existing knowledge independently; quality awareness; skill to present and document results in an understandable way; practical experience and professional qualification.

Workload:

Total: 180 h
22 h studying of course content using provided materials (self-study)
23 h studying of course content using literarture (self-study)
45 h lecture (attendance)
60 h studying of course content through exercises / case studies (self-study)
30 h exercise course (attendance)

Conditions: The previous course "Software Architectures and Enterprise Architecture Management" and the course "Software-intensive Systems and Medical Devices" must not have been taken due to overlaps.		
Frequency: each winter semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 5	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Software-intensive Systeme (Vorlesung)
Mode of Instruction: lecture
Language: German
Contact Hours: 3

Contents:

The lecture content includes patterns, modelling techniques and the evaluation of software architectures. Furthermore, the area of enterprise architecture management is addressed.

Literature:

- Bass et al: Software Architecture in Practice
- Clements et al: Documenting Software Architectures
- Clements et al: Evaluation of Software Architectures
- Kopetz: Real-Time Systems

Part of the Module: Software-intensive Systeme (Übung)
Mode of Instruction: exercise course
Language: German
Contact Hours: 2

Examination
Software-intensive Systeme
oral exam / length of examination: 30 minutes
Test Frequency:
when a course is offered

Module INF-0309: Real-Time Systems *Echtzeitsysteme*	8 ECTS/LP

Version 1.7.0 (since WS19/20)
Person responsible for module:
Prof. Dr. Sebastian Altmeyer

Learning Outcomes / Competences:
The lecture imparts basic and advanced knowledge of real-time systems as they occur in almost all embedded systems, but especially in the areas of automotive, aerospace and robotics. The theoretical foundations will be based on the current state of research and will enable students to further engage with the topic of embedded real-time systems at a scientific level.

The lecture will provide students with the ability to distinguish and classify different embedded systems based on their real-time requirements. Students will learn to apply, compare, and critically analyze current methods for validation of timing behavior with respect to possible certification of timing behavior. This includes the optimization and selection of real-time schedules and their verification. The lecture will also cover different processor types, and will go into more detail about the specifics of single-core and multi-core processors in the real-time domain. Students will be able to classify processors based on their suitability for real-time systems and to investigate the impact of design decisions on real-time behavior and real-time behavior analysis.

The course material will be exemplified by case studies from the automotive and aerospace fields and applied by the students using a simple real-time system.

Key qualifications: Analytical-methodical competence, consideration of approaches to solutions, presentation of solutions to exercise problems; skill in presenting and documenting results in a comprehensible manner; ability to expand existing knowledge independently; quality awareness, meticulousness; self-reflection; responsible action against a background of inadequacy and conflicting interests.

Workload:
Total: 240 h
30 h studying of course content using literarture (self-study)
90 h studying of course content through exercises / case studies (self-study)
30 h studying of course content using provided materials (self-study)
60 h lecture (attendance)
30 h exercise course (attendance)

Conditions: none		
Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Echtzeitsysteme (Vorlesung)
Mode of Instruction: lecture
Language: German / English
Contact Hours: 4

Contents:

- WCET Analysis
- Scheduling Analysis
- Programming of real-time systems
- Processors for real-time systems
- Real-time operating systems
- Certification of real-time systems

Literature:

- Sanjoy Baruah, Marko Bertogna, Giorgio Buttazzo, Multiprocessor Scheduling for Real-Time Systems, Springer, 2015.
- Giorgio Buttazzo, Hard Real-Time Computing Systems: Predictable Scheduling Algorithms and Applications, Springer, 2011.
- Heinz Wörn, Uwe Brinkschulte, Echtzeitsysteme, Springer Verlag, Berlin/Heidelberg, 2005
- Uwe Brinkschulte, Theo Ungerer, Mikrocontroller und Mikroprozessoren, Springer Verlag, Heidelberg, dritte Auflage 2010

Part of the Module: Echtzeitsysteme (Übung)

Mode of Instruction: exercise course

Language: German

Contact Hours: 2

Examination

Echtzeitsysteme

oral exam / length of examination: 20 minutes

Module INF-0314: Seminar IT Infrastructure in Medical Information Systems for Master Students *Seminar IT-Infrastrukturen in der Medizin für Master*	4 ECTS/LP

Version 1.0.0 (since SoSe19)
Person responsible for module: Prof. Dr. Frank Kramer

Learning Outcomes / Competences:
After attending the seminar, students are able to independently develop, analyze and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of IT infrastructures for translational medical research in relation to the individual seminar topic from the mentioned field. They have the scientific methodology, communication skills and ability to use appropriate media to present a specific topic in a clear and comprehensible manner, both verbally and in writing, and to critically and argumentatively discuss and evaluate scientifically challenging topics from the named field. They will also be able to recognize the logical structures of reasoning and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a lecture in a clear and comprehensible way and how to focus the lecture on essential messages and convey them in a comprehensible way, even in the case of complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and how to deal confidently with common presentation media and to use them interactively. They manage to gear a lecture to a specific target group and to motivate the listener even during longer lecture durations and to apply various moderation techniques.
Key Skills: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and for their documentation; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management; Evaluation of approaches, procedures, techniques and technologies from different points of view.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		**Credit Requirements:** Passing the module examination
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar IT Infrastructure in Medical Information Systems for Master Students
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
Current topics of IT infrastructures in medicine

Literature:
will be presented in the respective kickoff event.

Assigned Courses:

Seminar IT-Infrastrukturen in der Medizin für Master (seminar)

Examination

Seminar IT Infrastructure in Medical Information Systems for Master Students

written/oral exam

Module INF-0315: Deep Learning

Deep Learning

5 ECTS/LP

Version 1.4.0 (since SoSe19)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
The course Deep Learning covers the historical and formal fundamentals of Neural Networks, as well as the core principles of Machine Learning and data modelling.
Upon completing the course, students will have the skills and knowledge to be able to choose suitable approaches and network architectures for specific tasks and know the pros and cons of design alternatives, as assessed in the respective application context. They will be able to apply and implement the discussed technical concepts in programs and systems. Furthermore, they will have the ability to analyse Deep Neural Network-based models and to design novel architectures and training methods.
During the course, the participants will improve their skills in logical, analytical, and conceptual thinking. Students will gain the ability to make scientifically meaningful assessments in the field of machine learning and data science using appropriate methods. They will get used to the way of thinking and the language of relevant disciplines.
Moreover, students will gain the ability to, convincingly, present their developed ideas and concepts. They will be able to apply their new knowledge to practical tasks and solve many real-life problems through the appropriate application of machine learning. They will also develop the competence to identify significant technical developments in the field.
Key qualifications: analytical skills, data science cross-disciplinary knowledge, procedures and processes in creating practical systems, ability to present and document results in a comprehensible way, skill to solve problems under practical conditions, self-reflection, quality awareness, meticulousness, teamwork

Workload:
Total: 150 h
15 h studying of course content using provided materials (self-study)
15 h studying of course content using literarture (self-study)
60 h studying of course content through exercises / case studies (self-study)
30 h lecture (attendance)
30 h exercise course (attendance)

Conditions:	**Credit Requirements:**
Knowledge of basic mathematic lectures should be present.	Bestehen der Modulprüfung

Frequency: usu. at least once per acad. year	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Deep Learning (Vorlesung)
Mode of Instruction: lecture
Language: German
Contact Hours: 2

Contents:
Perceptron, Feed-forward Neural Networks, Gradient-based Learning, Backpropagation, Recurrent Neural Networks, Convolutional Neural Networks, Autoencoders, Transfer Learning, Generative Adversarial Nets, Attention, Connectionist Temporal Classification, Data Preprocessing, Evaluation, Audio Classification, Object Detection, Natural Language Processing

Literature:

Ian Goodfellow; Yoshua Bengio; Aaron Courville (2016). *Deep Learning*. Cambridge, Massachusetts: MIT Press.

Further literature is going to be announced during the lecture.

Assigned Courses:

Deep Learning (lecture)

Part of the Module: Übung zu Deep Learning

Mode of Instruction: exercise course

Language: German

Contact Hours: 2

Assigned Courses:

Deep Learning (lecture)

Übung zu Deep Learning (exercise course)

Examination

Deep Learning

written exam / length of examination: 90 minutes

Module INF-0316: Machine Learning and Computer Vision *Machine Learning and Computer Vision*		8 ECTS/LP
Version 1.0.0 (since SoSe19) Person responsible for module: Prof. Dr. Rainer Lienhart		
Learning Outcomes / Competences: After successful participation in this module, students possess advanced knowledge of machine learning (decision trees, neural networks and deep neural networks, hypothesis evaluation, instance-based learning, Bayesian learning, learning theory), data reduction (e.g. principal component analysis), advanced image processing and machine vision and are able to apply them. They can analyse, understand and programmatically implement scientifically complex procedures in the field of multimedia data processing, as well as to appropriately apply the principles learned to new problems. They develop skills in logical, analytical and conceptual thinking in the field of digital signal processing and multimedia data processing. **Key qualifications**: advanced mathematical-formal logic; implementation of subject-specific solution concepts; interdisciplinary knowledge; development and implementation of solution strategies for complex problems; systematic further development of design methods; ability to solve problems under practical boundary conditions.		
Workload: Total: 240 h 30 h exercise course (attendance) 60 h lecture (attendance) 30 h studying of course content using provided materials (self-study) 90 h studying of course content through exercises / case studies (self-study) 30 h studying of course content using literarture (self-study)		
Conditions: none		
Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Machine Learning and Computer Vision (Lecture)
Mode of Instruction: lecture
Language: German
Contact Hours: 4

Contents:

The lecture gives a good overview of all aspects of machine learning and machine extraction of information from multimedia data (e.g. "Google Image Search", "Google Goggles"). The learned concepts will be practised, analysed, and evaluated in the exercises using successful examples from practice. At the end of the semester, advanced topics such as object detection and object recognition of faces and people will be covered. The contents of the lecture include: Machine Learning (Decision Tree Learning, Artificial Neural Networks, Bayesian Learning, Discrete Adaboot), Data Reduction (Quantization (K-Means Clustering, Affinity Propagation), Dimensionality Reduction Techniques (PCA, NMF, Random Projection, MDS)) and Image Processing & Computer Vision (Salient Feature Points and Feature Descriptors, Object Detection (Face/Car/People Detection), Object Recognition (Face Recognition), Image Search with pLSA).

Literature:

Literature references will be announced at the beginning of the semester.

Assigned Courses:

Machine Learning and Computer Vision (lecture)

Part of the Module: Machine Learning and Computer Vision (Tutorial)
Mode of Instruction: exercise course
Language: German
Contact Hours: 2

Assigned Courses:

Übung zu Machine Learning and Computer Vision (exercise course)

Examination
Machine Learning and Computer Vision (Exam)
written exam / length of examination: 120 minutes
Test Frequency:
each semester
Description:
The examination can be taken every semester during the examination period.

Module INF-0318: Practice Module on Simulation of Autonomous Vehicles

Praktikum Simulation von autonomen Fahrzeugen (Vertiefung)

8 ECTS/LP

Version 1.0.0 (since WS19/20)
Person responsible for module: Prof. Dr. Lars Mikelsons

Learning Outcomes / Competences:
Subject-related competencies:
After participating in the internship, students understand problems of higher complexity in the field of simulation of autonomous vehicles and have deeper technical knowledge and skills there. They are able to develop concepts, methods, procedures, techniques and technologies of the mentioned field in small groups and are able to apply innovative methods in solving problems. This enables them to connect to international research and implement existing concepts. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the field, define intermediate objectives, and critically evaluate, classify, combine and present intermediate results and innovative ideas.

Key Competencies:
Skill in logical, analytical, and conceptual thinking; Validation of simulation results and software modules; Independent work with English-language literature; Intelligible, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill in collaborating in teams and understanding team processes; Principles of good scientific practice; Project management skills; Scientific methodology;

Workload:
Total: 240 h
90 h internship / practical course (attendance)
150 h studying of course content through exercises / case studies (self-study)

Conditions: Good programming skills Helpful: Python, C++, ROS, Game Engines		**Credit Requirements:** Passing the module exam
Frequency: each winter semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practice Model on Simulation of Autonomous Vehicles (Advanced)
Mode of Instruction: internship
Language: German / English
Contact Hours: 6
ECTS Credits: 8.0

Contents:
In the practical course, students work in small groups on application-oriented tasks for the simulation of autonomous vehicles. They are allowed to implement and validate individual software modules of a virtual vehicle themselves.

Examination
Practice Model on Simulation of Autonomous Vehicles
portfolio exam

Module INF-0319: Interdisciplinary Project Engineering Informatics *Praktikum Interdisziplinäres Projekt Ingenieurinformatik*	6 ECTS/LP

Version 1.0.0 (since WS19/20)
Person responsible for module: Prof. Dr.-Ing. Johannes Schilp
Prof. Dr.-Ing. Lars Mikelsons, Prof. Dr.-Ing. Christoph Ament

Learning Outcomes / Competences:
The students deal with an interdisciplinary task from the field of production informatics, control engineering and mechatronics. They use complex processes and techniques, some of which have already been covered theoretically in the individual lectures. The practical project is based on a student challenge, such as the Sioux Mechatronics Trophy or the James Dyson Award, and is worked on in small groups. The use case requires the evaluation and transfer of concepts and methods as well as their interdisciplinary combination.
The timeline for this practicum will be announced in Digicampus, as will the specific challenge assignment, including prerequisites and faculty participation.
Key Qualifications: Teamwork and communication skills, structured and conscientious work, application-oriented problem solving, result evaluation and
-documentation, consideration of solutions, ability to think logically, analytically and conceptually, ability to think abstractly.

Workload:
Total: 180 h
120 h studying of course content through exercises / case studies (self-study)
60 h internship / practical course (attendance)

Conditions: none		**Credit Requirements:** Passing the module exam
Frequency: each summer semester	**Recommended Semester:**	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Interdisciplinary Project Engineering Informatics
Mode of Instruction: internship
Language: German
Contact Hours: 4
ECTS Credits: 6.0

Contents:
Students work in small groups on application-oriented tasks on topics in the industrial environment.

Literature:
Will be announced in the respective semester.

Examination
Interdisciplinary Project Engineering Informatics
practical exam

Module INF-0320: Seminar Process Mining *Seminar Process Mining*	4 ECTS/LP

Version 1.0.0 (since WS19/20)
Person responsible for module: Prof. Dr. Robert Lorenz

Learning Outcomes / Competences:
After attending the seminar, the students can independently work out and analyse advanced problems, concepts, methods, procedures, techniques, and technologies from the field of process mining and evaluate them in relation to the individual seminar topic.

Participants possess scientific methodology, communication skills, and the ability to present a special topic clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively.

Furthermore, they learn to recognise logical structures of thinking and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a talk that is clear and easy to follow. Additionally, the students know how to focus on essential messages and convey them in a comprehensible way, even with complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to confidently deal with common presentation media and use them interactively. They manage to gear a talk to a specific target group, apply various moderation techniques, and keep their audience engaged even over a longer period.

Key qualifications: Presentation techniques; literature research; principles of good scientific practice; evaluating solution approaches, procedures, techniques, and technologies from different points of view.

Workload:
Total: 120 h
45 h preparation of presentations (self-study)
45 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions:		**Credit Requirements:**
Module Process Mining (INF-0243) - required		Passing the module examination
Frequency: irregular	**Recommended Semester:** from 3.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Process Mining
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 4.0

Contents:
Current Research Topics in the Field of Process Mining: Process Discovery, Conformance Checking, Enhancement, Preprocessing of logs (clustering, filtering), Handling of Noise, Synthesis based methods, Process Mining and Data Mining, Statistical methods in Process Mining, case studies, tooling.

Das Seminar eignet sich zur Vorbereitung auf Abschlussarbeiten und Projektmodule.

Literature:
Literature depends on the chosen topic

Examination

Seminar Process Mining

written/oral exam / length of examination: 60 minutes

work period for assignment: 2 months

Module INF-0328: Project Module IT Infrastructure in Medical Information Systems *Projektmodul IT-Infrastrukturen in der Medizin*	10 ECTS/LP

Version 1.0.0 (since WS19/20)
Person responsible for module: Prof. Dr. Frank Kramer

Learning Outcomes / Competences:
After participating in the project module, students understand problems of higher complexity in the field of IT infrastructures in translational medical research and have deeper expertise and skills there. They are able to develop concepts, methods, procedures, techniques and technologies of the mentioned field in research projects and are able to apply innovative methods in solving
problems. This enables them to connect to international research and make their own scientific contribution to the field. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine and present intermediate results and innovative ideas.
Key Skills: Skill in logical, analytical, and conceptual thinking; Independent work with English-language literature; Intelligible, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill in working in teams and understanding team processes; Principles of good scientific practice; Project management skills; Scientific methodology.

Workload:
Total: 300 h
285 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		**Credit Requirements:** Passing the module examination
Frequency: each semester	**Recommended Semester:** from 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Project Module IT Infrastructure in Medical Information Systems
Mode of Instruction: internship
Language: German / English
Contact Hours: 1
ECTS Credits: 10.0

Contents:
Current research topics in the field of IT infrastructures in translational medical research.

Literature:
scientific essays, manuals

Assigned Courses:

Oberseminar IT-Infrastrukturen für die Translationale Medizinische Forschung

Examination
Project Module IT Infrastructure in Medical Information Systems
practical exam

Module INF-0331: Seminar Computational Intelligence (Master) *Seminar Computational Intelligence (Master)*	4 ECTS/LP
Version 1.0.0 (since SoSe20) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:
After attending the seminar, students will be able to autonomously acquire and understand advanced problem statements, concepts, methods, approaches, techniques, and technologies in the field of Computational Intelligence. They possess the scientific techniques, communication skills, and the ability to employ suitable media, to present understandingly a special topic in spoken and written, and to discuss and evaluate scientifically challenging themes from the field in a critical way. Furthermore, they can recognise logical structures of thinking and debating and employ them constructively.
Participants can express themselves in a clear and understandable way and present scientific topics. They understand how to structure a talk, to focus it - also given a complex content - on the essential messages, and to communicate them in a suitable way. The lines of arguments and strategies in case of disturbances are applied by the students. Students know how to perform energetically, to cope with the presentation media and to use them interactively. They manage to orient a talk toward a certain audience, to motivate the listeners also over a longer duration, and to employ different methods of moderation.

Key qualifications: Fundamentals of good scientific practice; Analytical-methodological competency; Time management; Literature research; Self-contained work with English technical literature; Communication skills; Ability to present (in written and spoken) practical and theoretical ideas in an understandable, confident, and convincing way; Writing a report in the markup language LaTeX; Evaluation of methods, technologies, and solutions w.r.t. different aspects; Quality awareness.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Computational Intelligence (Master)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
Fuzzy Logic, Neural Networks, Evolutionary Computation, Learning Theory, Probabilistic Methods

Literature:
To be announced by the lecturers.

Assigned Courses:

Seminar Computational Intelligence (Bachelor & Master) (seminar)

Examination

Seminar Computational Intelligence (Master)

written/oral exam

Module INF-0337: Seminar Embedded Systems (Master) *Seminar Embedded Systems (Master)*	4 ECTS/LP
Version 1.0.0 (since SoSe20) Person responsible for module: Prof. Dr. Sebastian Altmeyer	

Learning Outcomes / Competences:

After attending the seminar, students are able to independently develop, analyze and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of embedded systems in relation to the individual seminar topic from the named field.

They have the scientific methodology, communication skills and ability to use appropriate media to present a specific topic in a clear and comprehensible manner, both verbally and in writing, and to discuss and evaluate scientifically challenging topics from the aforementioned field in a critical and argumentative manner. They will also be able to recognize the logical structures of reasoning and argumentation and use them in a goal-oriented manner.

The participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a scientific presentation in a clear and comprehensible way and how to focus the presentation on essential messages and convey them in a comprehensible way, even in the case of complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and how to deal confidently with common presentation media and to use them interactively. They manage to gear a presentation to a specific target group and to motivate the listener even during longer presentation durations and to apply various moderation techniques.

Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and for their documentation; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management; Evaluation of approaches, procedures, techniques and technologies from different points of view.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		
Frequency: each semester	**Recommended Semester:** 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Embedded Systems (Master)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:

In the seminar, topics from the field of embedded systems will be covered. Each seminar participant receives individual literature references, which are then to be supplemented in the course of the seminar by further independently compiled references. The seminar will end with a written paper and a presentation on the topic covered.

Literature:
given individually and self research

Assigned Courses:

Seminar Embedded Systems (Master) (seminar)

Examination

Seminar Embedded Systems (Master)
written/oral exam

Module INF-0340: Project Module Embedded Systems *Projektmodul Embedded Systems*	10 ECTS/LP
Version 1.0.0 (since SoSe20) Person responsible for module: Prof. Dr. Sebastian Altmeyer	

Learning Outcomes / Competences:
After participating in the project module, students understand problems of higher complexity in the field of embedded systems and have more in-depth specialist knowledge and skills there. They are able to develop concepts, methods, procedures, techniques and technologies of the mentioned field in research projects and are able to apply innovative methods in solving problems. This enables them to connect to international research and make their own scientific contribution to the field. In addition, students have the teamwork and communication skills, the ability to research literature and the scientific methodology to discuss problems in the field, define intermediate goals, and critically evaluate, classify, combine and present intermediate results and innovative ideas.

Key qualifications: Skill in logical, analytical, and conceptual thinking; Independent work with English-language literature; Intelligible, confident, and persuasive presentation of ideas, concepts, and results; Quality awareness; Communication skills; Skill in working in teams and understanding team processes; Principles of good scientific practice; Project management skills; Scientific methodology.

Workload:
Total: 300 h
285 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projektmodul Embedded Systems
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Autonomous collaboration on current research topics.

Literature:
scientific papers, handbooks

Assigned Courses:

Oberseminar Embedded Systems

Examination
Projektmodul Embedded Systems
practical exam

Module INF-0342: Seminar Digital Health (Master) *Seminar Digital Health (Master)*	4 ECTS/LP
Version 1.0.0 (since SoSe20) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:
After attending the seminar, students will be able to autonomously acquire and understand advanced problem statements, concepts, methods, approaches, techniques, and technologies in the field of Digital Health. They possess the scientific techniques, communication skills, and the ability to employ suitable media, to present understandingly a special topic in spoken and written, and to discuss and evaluate scientifically challenging themes from the field in a critical way. Furthermore, they can recognise logical structures of thinking and debating and employ them constructively.
Participants can express themselves in a clear and understandable way and present scientific topics. They understand how to structure a talk, to focus it - also given a complex content - on the essential messages, and to communicate them in a suitable way. The lines of arguments and strategies in case of disturbances are applied by the students. Students know how to perform energetically, to cope with the presentation media and to use them interactively. They manage to orient a talk toward a certain audience, to motivate the listeners also over a longer duration, and to employ different methods of moderation.

Key skills: Fundamentals of good scientific practice; Analytical-methodological competency; Time management; Literature research; Self-contained work with English technical literature; Communication skills; Ability to present (in written and spoken) practical and theoretical ideas in an understandable, confident, and convincing way; Writing a report in the markup language LaTeX; Evaluation of methods, technologies, and solutions w.r.t. different aspects; Quality awareness.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 5.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Digital Health (Master)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
In the seminar Digital Health, recent research works in this field are going to be discussed. This comprises both the acquisition of data through sensors and (e.g., microphones or electrodes) and the analysis and the modelling of the data. One important aspect is also the practicability of modern deep learning methods. Digital Health applications reach from tracking of health states (e.g., epilepsy or depression) to personal assistance services. The participating students will work on a certain aspect, supervised by a research associate of the chair. They will summarise their results in a written report and an oral presentation.

Topics: E-Health, M-Health, Sensor Signal Analysis, Vital Signs, Big Data.

Literature:

To be announced by the lecturer

Assigned Courses:

Seminar Digital Health (Bachelor & Master) (seminar)

Examination

Seminar Digital Health (Master)

written/oral exam

Module INF-0344: Seminar Software Engineering of Distributed Systems (MA) *Seminar Software Engineering verteilter Systeme (MA)*	4 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students can independently develop, analyze and evaluate advanced problems, concepts, methods, procedures, techniques, and technologies in software engineering for distributed systems about the particular seminar topic from the named field. They have the scientific methodology, communication skills, and ability to use appropriate media to present a specific case clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably, focus the study on essential messages, and understandably convey them, even with complex content. They skillfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and confidently deal with joint presentation media and use them interactively. They manage to gear a lecture to a specific target group, motivate the listener even during longer lecture durations, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management; evaluation of approaches, procedures, techniques, and technologies from different points of view. Translated with www.DeepL.com/Translator (free version)

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions:
The previous course "Seminar on Software Engineering of Distributed Systems (MA)" (INF-0039) must not have been taken due to overlaps.

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Software Engineering verteilter Systeme (MA)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current software engineering topics from industry and research.

Literature:
Will be presented in the respective kick-off event.

Assigned Courses:

Seminar Software Engineering verteilter Systeme (Master) (seminar)

Examination

Seminar Software Engineering verteilter Systeme (MA)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0346: Seminar Automotive Software and Systems Engineering (MA) *Seminar Automotive Software and Systems Engineering (MA)*	4 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students can independently analyze and evaluate advanced problems, concepts, methods, procedures, techniques, and technologies in Automotive Software & Systems Engineering about the particular seminar topic from the named area. They have the scientific methodology, communication skills, and ability to use appropriate media to present a specific case clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably, focus the study on important messages, and understandably convey them, even with complex content. They skillfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and confidently deal with joint presentation media and use them interactively. They manage to gear a lecture to a specific target group, motivate the listener even during longer lecture durations, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management; evaluation of approaches, procedures, techniques, and technologies from different points of view. Translated with www.DeepL.com/Translator (free version)

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions:
The previous course "Seminar Fundamentals of Software Engineering for Automotive Systems (MA)" (INF-0040) must not have been taken due to overlaps.

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Automotive Software and Systems Engineering (MA)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current software engineering topics from industry and research.

Literature:
Will be presented in the respective kick-off event.

Examination

Seminar Automotive Software and Systems Engineering (MA)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0348: Seminar Avionic Software and Systems Engineering (MA) *Seminar Avionic Software and Systems Engineering (MA)*	4 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students can independently analyze and evaluate advanced problems, concepts, methods, procedures, techniques, and technologies in Avionic Software & Systems Engineering about the particular seminar topic from the named field. They have the scientific methodology, communication skills, and ability to use appropriate media to present a specific case clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably focus the study on important messages and understandably convey them, even in the case of complex content. They skillfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and confidently deal with joint presentation media and use them interactively. They manage to gear a lecture to a specific target group, motivate the listener even during longer lecture durations, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management; evaluation of approaches, procedures, techniques, and technologies from different points of view. Translated with www.DeepL.com/Translator (free version)

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions:
The previous course "Seminar Grundlagen des Software Engineering für Avionic Systems (MA)" (INF-0041) must not have been taken due to overlaps.

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Avionic Software and Systems Engineering (MA)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current software engineering topics from industry and research.

Literature:
Will be presented in the respective kick-off event.

Examination

Seminar Avionic Software and Systems Engineering (MA)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0349: Seminar Human-Centered Artificial Intelligence *Seminar Menschzentrierte Künstliche Intelligenz*	4 ECTS/LP

Version 1.0.0 (since SoSe20)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After attending the seminar, students are able to independently work out, analyze and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of "human-centered artificial intelligence" related to the individual seminar topic from the mentioned field. They have the scientific methodology, communication skills and ability to use appropriate media to present a specific topic in a clear and comprehensible manner, both verbally and in writing, and to critically and argumentatively discuss and evaluate scientifically challenging topics from the named field. They will also be able to recognize the logical structures of reasoning and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a lecture in a clear and comprehensible way and how to focus the lecture on essential messages and convey them in a comprehensible way, even in the case of complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and how to deal confidently with common presentation media and to use them interactively. They manage to gear a lecture to a specific target group and to motivate the listener even during longer lecture durations and to apply various moderation techniques.

Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and for their documentation; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management.

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Human-Centered Artificial Intelligence
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Topics in the field of "Human-Centered Artificial Intelligence"

Literature:
References will be announced at the preliminary meeting.

Assigned Courses:

Seminar zu Menschzentrierte Künstliche Intelligenz (seminar)

Examination

Seminar Human-Centered Artificial Intelligence

written/oral exam

Module INF-0364: Seminar Software Engineering in Safety- and Security-Critical Systems (MA) *Seminar Software Engineering in sicherheitskritischen Systemen (MA)*	4 ECTS/LP

Version 1.0.0 (since WS20/21)
Person responsible for module: Prof. Dr. Bernhard Bauer

Learning Outcomes / Competences:
After attending the seminar, students can independently develop, analyze and evaluate advanced problems, concepts, methods, procedures, techniques, and technologies in software engineering in safety-critical systems and related disciplines about the particular seminar topic from the named field. They have the scientific methodology, communication skills, and ability to use appropriate media to present a specific case clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably, focus on essential messages, and coherently convey them, even with complex content. They skillfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and confidently deal with joint presentation media and use them interactively. They manage to gear a lecture to a specific target group, motivate the listener even during longer lecture durations, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management; evaluation of approaches, procedures, techniques, and technologies from different points of view. Translated with www.DeepL.com/Translator (free version)

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions:
none

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Software Engineering in sicherheitskritischen Systemen (MA)
Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:
Current software engineering topics from industry and research.

Literature:
Will be presented in the respective kick-off event.

Assigned Courses:

Seminar Software Engineering in sicherheitskritischen Systemen (Master) (seminar)

Examination

Seminar Software Engineering in sicherheitskritischen Systemen (MA)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0367: Advanced Machine Learning and Computer Vision	5 ECTS/LP
Version 1.0.0 (since WS20/21) Person responsible for module: Prof. Dr. Rainer Lienhart	

Learning Outcomes / Competences:
After successful participation in this module, students have in-depth advanced knowledge of machine learning (support vector machines and deep neural networks and their basic building blocks) and machine vision (deep neural network architectures and systems) and can apply these. They can analyse, understand and programmatically implement scientifically complex procedures in the field of image, text, video and signal processing, as well as to appropriately apply the principles learned to new problems. They develop skills in logical, analytical and conceptual thinking in the field of machine learning and vision.

Key qualifications: advanced mathematical-formal logic; critical reading and analysis of scientific publications; implementation of technical solution concepts; interdisciplinary knowledge; development and implementation of solution strategies of complex problems; systematic further development of design methods; skills in solving problems under practical boundary conditions

Workload:
Total: 150 h
30 h lecture (attendance)
60 h studying of course content through exercises / case studies (self-study)
30 h exercise course (attendance)
15 h studying of course content using literarture (self-study)
15 h studying of course content using provided materials (self-study)

Conditions:	**Credit Requirements:**
Kenntnisse in maschinellem Lernen und maschinellem Sehen (Master-Vorlesung INF-0092 "Multimedia II" bzw. INF-0316 "Machine Learning and Computer Vision")	Bestehen der Modulprüfung

Frequency: each winter semester	**Recommended Semester:** from 2.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Advanced Machine Learning and Computer Vision (Lecture)
Mode of Instruction: lecture
Language: German
Contact Hours: 2

Contents:
The lecture gives an in-depth insight into all aspects of machine learning and machine vision. The concepts learned will be practiced, analyzed and evaluated in the exercises using successful real-world examples. The contents of the lecture include: support vector machines, basic building blocks of deep neural networks (layer structures, normalization, attention mechanisms), as well as current reference architectures and systems for image, text, video processing and their combination with further sensor signals.

Literature:
Will be announced at the beginning of the semester.

Part of the Module: Advanced Machine Learning and Computer Vision (Tutorial)
Mode of Instruction: exercise course
Language: German
Contact Hours: 2

Examination
Advanced Machine Learning and Computer Vision (Examination)
written exam / length of examination: 90 minutes
Test Frequency:
each semester
Description:
The examination can be taken every semester during the examination period.

Module INF-0371: Approximation Algorithms

Approximation Algorithms

5 ECTS/LP

Version 1.2.0 (since WS20/21)
Person responsible for module: Prof. Dr. Tobias Mömke

Learning Outcomes / Competences:
Developing an understanding of central topics in the field of approximation algorithms; acquiring powerful mathematical tools to analyze algorithms; improve the ability to abstract and systematically solve optimization problems.

Key Skills: Ability to build intuitive understanding of mathematical formalisms; ability to identify core properties of optimization problems; deep understanding of powerful mathematical tools

Workload:
Total: 150 h
30 h exercise course (attendance)
30 h lecture (attendance)
60 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)
15 h studying of course content using provided materials (self-study)

Conditions:
Basic knowledge of Algorithms and Data Structures (e.g., "INF-0111: Informatik 3") and Theoretical Computer Science (e.g., "INF-0110: Einführung in die Theoretische Informatik").

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Approximation Algorithms (Vorlesung)

Mode of Instruction: lecture
Language: German / English
Contact Hours: 2

Contents:

Given an NP-hard optimization problem, how well can it be approximated in polynomial time? It is exciting and challenging to understand the approximability of fundamental optimization problems. This course mainly focuses on upper bounds, i.e., designing efficient approximation algorithms.

In this course, we will study several classes of problems, such as packing problems, network design, and graph problems. We will cover central algorithmic techniques for designing approximation algorithms, including greedy algorithms, dynamic programming, linear and semi-definite programming, and randomization.

Literature:

- David P. Williamson and David B. Shmoys, The Design of Approximation Algorithms, Cambridge University Press.
- Vijay V. Vazirani, Approximation Algorithms, Springer.

Part of the Module: Approximation Algorithms (Übung)

Mode of Instruction: exercise course
Language: English / German
Contact Hours: 2

Examination

Approximation Algorithms

written exam / length of examination: 120 minutes

Module INF-0374: Project Module Resource Aware Algorithms *Projektmodul Resource Aware Algorithms*	10 ECTS/LP
Version 1.0.0 (since WS20/21) Person responsible for module: Prof. Dr. Tobias Mömke	

Learning Outcomes / Competences:
After attending this research module, the students are able to understand algorithmic problems and solutions of medium difficulty in the area of resource aware algorithmics.They have acquired a detailed understanding of up-to-date topics within the area and can actively participate in research projects. Furthermore, they understand some deep concepts, methods, tools and technologies and can apply the acquired knowledge in research projects. Besides the technical abilities, they train their team and communication skills, the ability to perform literature research and to discurss and present technical topics.

Key Qualifications: Ability to perform analytical and logic thinking; self-sufficient work with scientific literature in English language; ability to present results and ideas in form of understandable and inspiring presentations; aim for high-quality results; communication skills; ability to work with a team and to understand team processes; respect for clean scientific practices

Workload:
Total: 300 h
285 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projekt Module Resource Aware Algorithmics
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Autonome Mitarbeit an aktuelle Forschungsthemen.

Literature:
wissenschaftliche Papiere, Handbücher

Assigned Courses:

Oberseminar Resource Aware Algorithmics

Examination
Projekt Module Resource Aware Algorithmics
portfolio exam

Module INF-0379: Practical Module Simulation of Cyber-Physical Systems *Praktikum Simulation cyber-physischer Systeme*	6 ECTS/LP
Version 1.0.0 (since SoSe21) Person responsible for module: Prof. Dr. Lars Mikelsons	

Learning Outcomes / Competences:

Subject-related competences:

After successful participation in this module, students will be able to apply advanced methods of simulation to use virtual prototypes for model-based development of mechatronic systems. They know methods for different application areas along the development process and interpret their result.

Methodological competencies:

Students are able to evaluate different simulation methods for different application areas. They are also able to select and independently apply suitable simulation methods depending on the simulation purpose.

Interdisciplinary competencies:

Students are able to solve certain engineering problems with the help of information technology. They can use abstractions of physical systems and apply them in combination with information technology methods for the development of mechatronic systems.

Key Competencies:

Advanced skill in answering engineering questions, particularly in the area of mechatronic systems design, using virtual prototypes; selection and application of advanced simulation methods; assessment and analysis of mathematical models.

Workload:

Total: 180 h

90 h internship / practical course (attendance)

90 h studying of course content through exercises / case studies (self-study)

Conditions: Attendance of the course Mechatronics and/or object-oriented methods of modeling and simulation.		**Credit Requirements:** Passing the module exam
Frequency: each summer semester	**Recommended Semester:** from 4.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktical Module Simulation of Cyber-Physical Systems

Mode of Instruction: internship

Lecturers: Prof. Dr. Lars Mikelsons

Language: German / English

Contact Hours: 6

Contents:

Nowadays, the development of mechatronic systems is generally model-based. In doing so, the application of simulation in practice often encounters the following challenges:

- How do I improve a physical model when measurements become available?
- How do I know how much I can trust my model?
- How do I combine simulation of physical systems with virtual control units?
- How can I even use simulation to investigate the safety of the real system?

In this lab, students will learn methods for answering these (and other) questions and apply what they learn through hands-on exercises. Experts from industrial practice are brought in for some parts of the course.

Assigned Courses:

Praktikum Simulation cyber-physischer Systeme (internship)

Examination

Praktical Module Simulation of Cyber-Physical Systems

portfolio exam / length of examination: 30 minutes

Module INF-0380: Digital Health *Digital Health*	5 ECTS/LP
Version 1.0.0 (since SoSe21) Person responsible for module: Prof. Dr. Björn Schuller	

Learning Outcomes / Competences:

Knowledge: Digital health is the use of information and communication technology for disease prevention and treatment. Students will get to know the key concepts, definitions, and technologies in the field of digital health. They will get insights into acceptability and usability of digital health applications in the context of various diseases such as depression, multiple sclerosis, and autism spectrum disorder. They will learn strategies for collecting medically-relevant data of various modalities, e.g., recording speech data using microphones or tracking heart rate via wearables. They will then learn about principal concepts of intelligent biosignal processing and analysis including feature extraction and machine learning in the context of healthcare applications. Finally, students will be made familiar with current and potential future implications of intelligent biosignal analysis to the health sector as well as sensitised to related ethical and data privacy aspects.

Skills: Students will be familiar with the basic concepts of digital health and its fields of application in modern healthcare. Students will be able to select appropriate methodology or design new approaches to be applied to a broad range of health-related signal processing and analysis tasks. Moreover, they will practice logical and conceptual thinking and combine knowledge of state-of-the-art technology and medical requirements in order to develop solutions for real-world scenarios in a healthcare context.

Competences: Students are prepared to work closely with healthcare professionals in interdisciplinary research and intervention projects. Students are able to plan and carry out medical data collections for health-related biosignal analysis tasks under consideration of ethical principles and data privacy regulations. They can cope with tools to extract meaningful information from the collected data. Furthermore, they know how to characterise and judge on the quality and suitability of existing approaches as well as design new intelligent biosignal processing and analysis solutions for healthcare applications. They are further able to realise the learnt concepts in programs and know how to make scientifically meaningful performance evaluations of the proposed systems.

Key skills: Formal methods; Knowledge of advantages and disadvantages of different design alternatives; Systematical advancement of design tools; Ability to work in teams; Knowledge of workflows and processes; Ability to find solutions for practical problems; Ability to work autonomously; Quality awareness; Scientific working; Literature research.

Workload:
Total: 150 h
30 h exercise course (attendance)
60 h studying of course content through exercises / case studies (self-study)
30 h lecture (attendance)
15 h studying of course content using literarture (self-study)
15 h studying of course content using provided materials (self-study)

Conditions:	**Credit Requirements:**
Basic knowledge of mathematics as well as interest in healthcare applications should be present.	Bestehen der Modulprüfung

Frequency: irregular (usu. summer semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Digital Health (Vorlesung)
Mode of Instruction: lecture
Language: English
Contact Hours: 2

Contents:

Public health, personalised medicine, usability, Internet of Things, digital health interventions, self-tracking, digital biomarker, medical data acquisition, wearables, digital signal processing, signal enhancement, feature extraction, machine learning, ethics, and data privacy.

Literature:

Panesar, A (2019): Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes. Coventry, UK: Apress.

Assigned Courses:

Digital Health (lecture)

Part of the Module: Digital Health (Übung)
Mode of Instruction: exercise course
Language: English
Contact Hours: 2

Assigned Courses:

Übung zu Digital Health (exercise course)

Examination
Digital Health

written exam / length of examination: 90 minutes

Module INF-0383: Algorithms for Big Data *Algorithmen für Big Data*		5 ECTS/LP
Version 1.0.0 (since SoSe21) Person responsible for module: Prof. Dr. Tobias Mömke		
Learning Outcomes / Competences: Development and understanding of central copetences in algorithm design for situations, where there are large amounts of data such that not all of them can be accessed without restrictions; aquisition of knowledge of mathematical tools to analyze algorithms; improvement of copetences in abstract thinking and analyzing problems in a systematic manner. **Key Qualifications:** Ability to develop an intuitive understanding of mathematical formalisms; ability to identify the core properties of algirthmic problems; deep understanding of useful mathematical tools		
Workload: Total: 150 h 30 h exercise course (attendance) 30 h lecture (attendance) 15 h studying of course content using provided materials (self-study) 60 h studying of course content through exercises / case studies (self-study) 15 h studying of course content using literarture (self-study)		
Conditions: Basic knowledge in algorithms and data structures (for example Informatik 3 (INF-0111)) and in probability theory (for example Stochastik für Informatiker (MTH-6040)).		
Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Algorithms for Big Data (lecture)
Mode of Instruction: lecture
Language: German / English
Contact Hours: 2

Contents:

In modern data processing, we increasingly have the problem that there are large quantities of data whcih con only be stored on cheap and slow mass storage media. Algorithmically, this poses the problem that at each point in time, we can only access a snapshot of the data, for example in a sequential manner. In the course, we study algorithms that despite such limitations provably yield high quality results.

Literature:

Wissenschaftliche Papiere, Surveys, Skripte

Assigned Courses:

Algorithmen für Big Data (lecture)

Part of the Module: Algorithms for Big Data (exercise)
Mode of Instruction: exercise course
Language: English / German
Contact Hours: 2

Assigned Courses:

Übung zu Algorithmen für Big Data (exercise course)

Examination

Algorithms for Big Data

written exam / length of examination: 90 minutes

Module INF-0385: Seminar Resource Aware Algorithms (Master) *Seminar Resource Aware Algorithms (Master)*	4 ECTS/LP

Version 1.0.0 (since SoSe21)
Person responsible for module: Prof. Dr. Tobias Mömke

Learning Outcomes / Competences:
After attending the seminar, the students are able to understand basic algorithmic concepts, methods, tools and techniques in a self-sufficient manner.

They have acquired communication skills, knowledge about work processes and the use of media to present a specific scientific topic both as a talk and in writte form.

The participants have learned to express techical contents in a sturctured, understandable and inspiring manner. They have learned to confidently stand in front of the audience, using state of the art presentation tools and media. They are able to tailor the talk to the respective audience.

Key Qualifications: Literature research; work with scientific literature in English language; analytic copetences; clean scientific practice; ability to present techincal content in confident, understandable and structured manner (both in written and spoken form); abstract, logical and analytical thinking; ability to argue formally; aim for high quality; communication skills; time management.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions:	**Credit Requirements:**
Good knowledge of content taught in mathematical Bachelor classes such as "Mathematik für Informatiker 1" and "Diskrete Strukturen und Logik." Knowledge about algorithms and data structures (Informatik 3) is useful.	Passing of the module exam

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Resource Aware Algorithmics (Master)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
The topics of the seminar are related to research in resource aware algorithmics. The precise topics change over time, in order to reflect up-to-date developments.

Literature:
Depending on the topic of the seminar.

Assigned Courses:

Seminar Resource Aware Algorithmics (Master) (seminar)

Examination
Seminar Resource Aware Algorithmics (Master)
written/oral exam

Module INF-0398: Software-intensive Systems and Medical Products *Software-intensive Systeme und Medizinprodukte*	6 ECTS/LP
Version 1.0.0 (since WS21/22) Person responsible for module: Prof. Dr. Bernhard Bauer	

Learning Outcomes / Competences:
Students can create (K3), evaluate (K6), and document software architectures.
To this end, they can transfer technical solution concepts into models and know methods for developing such abstractions and architectures.
Such abstractions and architectures. They can describe the advantages and disadvantages of design alternatives (K4).
(K4) and can evaluate them in the respective application context (K6). Problems can be identified independently (K4), and solutions can be designed systematically (K5) and realized (K3).

Furthermore, they have basic knowledge of creating medical software according to the particular requirements for conformity assessment. Based on the European Medical Device Regulation (MDR), students learn how to implement the required software life cycle process according to IEC 62304 and IEC 82304, the requirements for software requirement management, the link between (agile) software development and the documentation obligation, requirements regarding safety and security.

Key qualifications: Competence in networking different specialist areas; teamwork and communication skills; ability to expand existing knowledge independently; quality awareness; ability to present and document results in an understandable way; practical experience and professional qualifications.

Workload:
Total: 180 h
23 h studying of course content using literarture (self-study)
22 h studying of course content using provided materials (self-study)
60 h studying of course content through exercises / case studies (self-study)
45 h lecture (attendance)
30 h exercise course (attendance)

Conditions: The previous course "Software Architectures and Enterprise Architecture Management" and the course "Software-intensive Systems" must not have been taken due to overlaps.		
Frequency: each winter semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 5	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Software-intensive Systeme und Medizinprodukte (Vorlesung)
Mode of Instruction: lecture
Language: German
Contact Hours: 3

Contents:
The lecture content includes patterns, modelling techniques and the evaluation of software architectures. Furthermore, the development of medical devices is dealt with.

Literature:

- Bass et al: Software Architecture in Practice
- Clements et al: Documenting Software Architectures
- Clements et al: Evaluation of Software Architectures
- Richard N. Taylor, Nenad Medvidovic, and Eric M. Dashofy; Software Architecture: Foundations, Theory, and Practice
- BSI Empfehlungen für Medizinprodukte
- ZVE Empfehlungen für Medizinprodukte

Part of the Module: Software-intensive Systeme und Medizinprodukte (Übung)

Mode of Instruction: exercise course

Language: German

Contact Hours: 2

Examination

Software-intensive Systeme

oral exam / length of examination: 30 minutes

Test Frequency:

when a course is offered

Module INF-0400: Knowledge Representation in Biomedicine *Knowledge Representation in Biomedicine*		5 ECTS/LP
Version 1.2.0 (since WS21/22) Person responsible for module: Prof. Dr. Frank Kramer Dr. Zaynab Hammoud		
Learning Outcomes / Competences: analytical and logical thinking, skill to solve complex problems under practical conditions, ability to present and document results in a comprehensible way, procedures and processes in creating practical systems, individual work with books and scientific literature, teamwork		
Workload: Total: 150 h 30 h (self-study) 30 h studying of course content through exercises / case studies (self-study) 30 h studying of course content using literarture (self-study) 30 h exercise course (attendance) 30 h lecture (attendance)		
Conditions: none		**Credit Requirements:** Passing the module exam
Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Knowledge Representation in Biomedicine
Mode of Instruction: lecture
Language: English
Contact Hours: 2
ECTS Credits: 3.0

Contents:

The course Knowledge representation in Biomedicine covers the different aspects and forms used to model biomedical knowledge. During this course, students will acquire logical and analytical skills. They will study different forms of knowledge such as terminologies, ontologies, controlled vocabulary, thesaurus and much more. Furthermore, they will learn the different between these types and will be able to develop new solutions and implement them using RDF, XML or UMLS formats. They will inspect practical examples of knowledge forms used in biomedicine.

Literature:

- Handbuch der Medizinischen Informatik, Thomas M. Lehmann, 2. Auflage, 2014
- Biomedizinische Ontologie: Wissen strukturieren für den Informatik-Einsatz, Ludger Jamsem, Barry Smith (Hrsg.), 2008

Part of the Module: Übung zu Knowledge Representation in Biomedicine
Mode of Instruction: exercise course
Language: English
Contact Hours: 2
ECTS Credits: 2.0

Examination

Knowledge Representation in Biomedicine

portfolio exam

Module INF-0407: Seminar Digital Ethics (Master) *Seminar Digitale Ethik (Master)*	4 ECTS/LP

Version 1.0.0 (since WS21/22)
Person responsible for module: Prof. Dr. Robert Lorenz

Learning Outcomes / Competences:
After attending the seminar, the students can independently work out and analyse advanced problems, concepts, methods, procedures, techniques, and technologies from the field of digital ethics and evaluate them in relation to the individual seminar topic.

Participants possess scientific methodology, communication skills, and the ability to present a special topic clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively.

Furthermore, they learn to recognise logical structures of thinking and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a talk that is clear and easy to follow. Additionally, the students know how to focus on essential messages and convey them in a comprehensible way, even with complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to confidently deal with common presentation media and use them interactively. They manage to gear a talk to a specific target group, apply various moderation techniques, and keep their audience engaged even over a longer period.

Key qualifications: Presentation techniques; literature research; principles of good scientific practice; evaluating solution approaches, procedures, techniques, and technologies from different points of view.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of presentations (self-study)

Conditions: none		**Credit Requirements:** Passing the module examination
Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Digital Ethics (Master)
Mode of Instruction: seminar
Language: English / German
Contact Hours: 2
ECTS Credits: 4.0

Contents:
The topics of the seminar change over time, in order to reflect up-to-date developments

Literature:
Literature depends on the chosen topic

Examination
Seminar Digital Ethics (Master)
presentation / length of examination: 45 minutes

Module INF-0408: Extremal Combinatorics *Extremal Combinatorics*		5 ECTS/LP
Version 1.0.0 (since SoSe22) Person responsible for module: Prof. Dr. Tobias Mömke		
Learning Outcomes / Competences: Being able to prove mathematical claims using counting, pigeonhole princple and the probabilistic method; improving the skills of analyzing performance of algorithms; enhancing the skills of mathematical thinking		
Workload: Total: 150 h 30 h exercise course (attendance) 15 h studying of course content using provided materials (self-study) 15 h studying of course content using literarture (self-study) 60 h studying of course content through exercises / case studies (self-study) 30 h lecture (attendance)		
Conditions: Basic knowledge in mathematics, in particular linear algebra is necessary. Basic knowledge in graph theory is recommended.		
Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Extremal Combinatorics (Vorlesung)
Mode of Instruction: lecture
Language: English
Contact Hours: 2

Contents:

How many people do you need to invite for your party, in order to have 3 strangers or a group of 3 friends? If 10 people have keys to a safe, how many locks are necessary to make sure any 5 of them can open it? What is the dictator paradox, and should you be worried about it? This course provides an introduction to extremal combinatorics, which helps us to find
answers to the questions above.

Literature:

Part of the Module: Extremal Combinatorics (Übung)
Mode of Instruction: exercise course
Language: English
Contact Hours: 2

Examination
Extremal Combinatorics

oral exam / length of examination: 45 minutes

Module INF-0409: Cyber Security *Cyber Security*	6 ECTS/LP
Version 1.0.0 (since SoSe22) Person responsible for module: Prof. Dr. Bernhard Bauer	

Learning Outcomes / Competences:
Students can create (K3), evaluate (K6), and document security aspects in the software development process and software architectures.
To this end, they can transfer technical solution concepts into development processes and IT architectures and know methods for developing secure software. They can describe the advantages and disadvantages of security alternatives (K4) and evaluate them in the respective application context (K6). Problems can be identified independently (K4) and solutions systematically designed (K5) and implemented (K3). Furthermore, they have developed skills for analyzing and structuring the problems of security architectures and know the concepts and procedures for creating such architectures. Students can name practice-relevant issues in security architectures and secure software development processes (K1). They can select suitable methods for
They can select and safely apply suitable methods for creating and evaluating security architectures. The students know concepts and technologies for developing secure software and security architectures. They have the competence to recognize significant technical developments.

Key qualification: Competence to network different subject areas; team and
ability to communicate; ability to expand existing knowledge independently; quality awareness; ability to present and document results understandably; practical experience and professional aptitude.

Workload:
Total: 180 h
23 h studying of course content using literarture (self-study)
22 h studying of course content using provided materials (self-study)
60 h studying of course content through exercises / case studies (self-study)
45 h lecture (attendance)
30 h exercise course (attendance)

Conditions: none		
Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 5	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Cyber Security (Vorlesung)
Mode of Instruction: lecture
Language: German
Contact Hours: 3

Contents:
The lecture content includes security standards, secure software development lifecycles, as well as security architectures, and their evaluation in respective technology contexts. and the evaluation of security architectures.

Literature:
- Slides
- A. Deane, A. Kraus: The Official (ISC)2 CISSP CBK Reference
- Further literature in the lecture on specific topics

Assigned Courses:

Cyber Security (lecture)

Part of the Module: Cyber Security (Übung)
Mode of Instruction: exercise course
Language: German
Contact Hours: 2

Assigned Courses:

Übung zu Cyber Security (exercise course)

Examination
Cyber Security
oral exam / length of examination: 30 minutes
Test Frequency:
when a course is offered

Module INF-0410: Gesture-Based Communication in Human-Computer Interaction *Gesture-Based Communication in Human-Computer Interaction*	8 ECTS/LP

Version 1.0.0 (since SoSe22)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After successful participation in this module, students understand the essential concepts of gesture-based communication in human-computer interaction. They are able to translate technical solution concepts into programs and models and master the selection and application of suitable methods. They have the knowledge of the way of thinking and the language of application-relevant disciplines. Within the framework of the lecture, they learn to evaluate learning components in a scientifically meaningful way using suitable methods, to develop the methods and algorithms independently and to implement them technically. Particularly promoted in this framework are also the skills for confident and convincing presentation of ideas and concepts, comprehensible presentation and documentation of results, as well as logical, analytical and conceptual thinking.

Key qualifications: Advanced mathematical formal methodology, skill in analyzing and structuring complex computer science problems, skill in developing and implementing solution strategies for complex problems, understanding of team processes, skill in collaborating in teams, self-reflection; acting responsibly in the face of inadequacy and conflicting interests, quality awareness, meticulousness.

Workload:
Total: 240 h
120 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)
15 h studying of course content using provided materials (self-study)
60 h exercise course (attendance)
30 h lecture (attendance)

Conditions: none		
Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Gesture-Based Communication in Human-Computer Interaction (Lecture)
Mode of Instruction: lecture
Language: English
Contact Hours: 2

Contents:
HCI methods and principles, Interaction design, Nonverbal communication, Gestures, Gesture recognition systems, Collaboration, Applied computer vision, Ubiquitous computing

Part of the Module: Gesture-Based Communication in Human-Computer Interaction (Exercise Course)
Mode of Instruction: exercise course
Language: English
Contact Hours: 4

Examination

Gesture-Based Communication in Human-Computer Interaction

portfolio exam

Module INF-0418: Practical Module Conversational AI: Virtual Assistants and Chatbots *Praktikum Conversational AI: Virtual Assistants and Chatbots*	5 ECTS/LP

Version 1.1.0 (since SoSe22)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
Students are familiar with methods and techniques of interaction design and engineering for health care applications. After successful participation, they will have the necessary knowledge to analyze application scenarios according to the guidelines of the user-centered design process and to design software solutions tailored to the target group. They are able to translate current interaction paradigms and design guidelines into models and programs for novel interaction devices, as well as to independently familiarize themselves with the necessary technologies. Furthermore, they are able to apply practice-relevant evaluation methods to assess the quality of the created software prototype. They are able to plan larger project tasks in small teams, solve them according to a self-developed project plan and discuss the results appropriately in plenary sessions and present them as a team.

Key qualifications: Skill in confident and persuasive presentation of ideas and concepts; knowledge of the mindset and language of application-relevant disciplines; understanding of team processes; skill in collaborating in teams; skill in leading teams; skill in presenting and documenting results in a comprehensible manner; ability to expand existing knowledge independently; ability to contribute to science; competence in recognizing significant technical developments; quality awareness, meticulousness.

Workload:
Total: 150 h
90 h studying of course content through exercises / case studies (self-study)
60 h internship / practical course (attendance)

Conditions: none		
Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Interaction Design and Engineering for Health Care Applications
Mode of Instruction: internship
Language: English
Contact Hours: 4

Contents:
The specific assignment for student projects is designed each year.

Literature:
Literature references will be announced at the beginning of the semester depending on the topic.

Examination
Practical Module Interaction Design and Engineering for Health Care Applications
practical exam

Module INF-0422: Seminar Organic Computing (Master) *Seminar Organic Computing (Master)*	4 ECTS/LP
Version 1.0.0 (since WS22/23) Person responsible for module: Prof. Dr. Jörg Hähner	

Learning Outcomes / Competences:

After attending the seminar, the students are able to independently work out advanced problems, concepts, methods, procedures, techniques and technologies in the fields of organic computing and to analyse and evaluate them in relation to the individual seminar topic from the named field.

They possess the scientific methodology, communication skills and ability to use appropriate media to present a special topic clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognise the logical structures of thinking and argumentation and use them in a goal-oriented manner.

Participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a presentation clearly and reasonable and how to focus on essentials and convey those in a comprehensible way, even with complex content. They skilfully apply lines of argument and solution strategies in the event of disruptions.

The students understand how to present themselves and confidently deal with common presentation media, using them interactively. They manage to gear a talk to a specific target group, motivate the listener even during longer talks and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; Analytical-methodical competence; scientific methodology; principles of good scientific practice; Ability to describe and document (practical and theoretical) ideas, concepts and results in a comprehensible, confident and convincing manner (written and oral); Ability to think logically, abstractly, analytically and conceptually and to argue formally; Quality awareness, meticulousness; Communication skills; Time management; Evaluation of approaches, procedures, techniques and technologies.

Workload:

Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions: none		
Frequency: each semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Organic Computing (Master)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 4.0

Contents:

The topics of the seminar are determined each year and adapted to current trends.

Literature:

Literature depending on the current topics: scientific papers or books.

Assigned Courses:

Seminar Organic Computing (Master) (seminar)

Examination

Presentation and written paper.

written/oral exam

Module INF-0424: Seminar Machine Learning (MA) *Seminar Machine Learning (MA)*	4 ECTS/LP
Version 1.0.0 (since WS22/23) Person responsible for module: Prof. Dr. Bernhard Bauer	

Learning Outcomes / Competences:

After attending the seminar, the students are able to independently work out, analyze and evaluate advanced problems, concepts, methods, procedures, techniques, and technologies in the field of Medical Information Sciences concerning the particular seminar topic from the named field. They have the scientific methodology, communication skills, and ability to use appropriate media to present a specific case clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. Furthermore, they can recognize the logical structures of thinking and argumentation and use them goal-oriented. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a lecture clearly and understandably, focus the study on important messages, and convey them in a comprehensible way, even with complex content. They skillfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and confidently deal with joint presentation media and use them interactively. They manage to gear a lecture to a specific target group, motivate the listener even during longer lecture durations, and apply various moderation techniques.

Key qualifications: Literature research; independent work with English-language specialist literature; analytical-methodical competence; scientific methodology; principles of good scientific practice; skills in the understandable, confident, and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts, and results and in documenting them; skills in logical, abstract, analytical and conceptual thinking and formal argumentation; quality awareness, meticulousness; communication skills; time management; evaluation of approaches, procedures, techniques, and technologies from different points of view. Translated with www.DeepL.com/Translator (free version)

Workload:

Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Machine Learning (Seminar)

Mode of Instruction: seminar
Language: German
Contact Hours: 2

Contents:

This seminar will cover the basics of Medical Information Sciences. Various topics are to be worked on, which are to serve as a basis for a subsequent practical course.

Literature:

Will be presented at the respective kick-off event.

Assigned Courses:

Seminar Machine Learning (Master) (seminar)

Examination

Presentation and written paper

written/oral exam

Test Frequency:

when a course is offered

Module INF-0427: Deep Ubiquitous and Wearable Computing for Healthcare *Deep Ubiquitous and Wearable Computing for Healthcare*	8 ECTS/LP

Version 1.0.0 (since WS22/23)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
Students are familiar with methods and techniques of interaction design and engineering for health care applications. After successful participation, they will have the necessary knowledge to analyze application scenarios according to the guidelines of the user-centered design process and to design software solutions tailored to the target group. They are able to translate current interaction paradigms and design guidelines into models and programs for novel interaction devices, as well as to independently familiarize themselves with the necessary technologies. Furthermore, they are able to apply practice-relevant evaluation methods to assess the quality of the created software prototype. They are able to plan larger project tasks in small teams, solve them according to a self-developed project plan and discuss the results appropriately in plenary sessions and present them as a team.

Key qualifications: Skill in confident and persuasive presentation of ideas and concepts; knowledge of the mindset and language of application-relevant disciplines; understanding of team processes; skill in collaborating in teams; skill in leading teams; skill in presenting and documenting results in a comprehensible manner; ability to expand existing knowledge independently; ability to contribute to science; competence in recognizing significant technical developments; quality awareness, meticulousness.

Workload:
Total: 240 h
15 h studying of course content using provided materials (self-study)
15 h studying of course content using literarture (self-study)
120 h studying of course content through exercises / case studies (self-study)
30 h lecture (attendance)
60 h exercise course (attendance)

Conditions: Programming experience		
Frequency: each winter semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Practical Module Interaction Design and Engineering for Health Care Applications
Mode of Instruction: lecture
Language: English
Frequency: each summer semester
Contact Hours: 2

Contents:
The specific assignment for student projects is designed each year.

Literature:
Literature references will be announced at the beginning of the semester depending on the topic.

Part of the Module: Deep Ubiquitous and Wearable Computing for Healthcare (Exercise Course)
Mode of Instruction: exercise course
Language: English
Contact Hours: 4

Examination
Practical Module Interaction Design and Engineering for Health Care Applications
portfolio exam

Module INF-0428: Practical Module Programming Parallel Embedded Systems *Praktikum Programming Parallel Embedded Systems*	5 ECTS/LP

Version 1.0.0 (since WS22/23)
Person responsible for module: Prof. Dr. Sebastian Altmeyer

Learning Outcomes / Competences:
The students analyse the particular requirements of embedded systems and optimise the software they develop regarding the available resources and mandatory time limits. They create parallel applications for embedded systems in an industry-typical programming language. The emerging problems of implementing multithreaded applications are identified and suitable solutions for those are developed. Different data structures for use in parallel applications are classified, their implementations are reviewed, and the performance is evaluated. Debugging and code-analysis techniques are applied, and different optimisation possibilities are investigated.
The students apply the skills they learned in projects, building parallel applications independently. Further, the performance of the developed software is evaluated, and analysed regarding the project requirements.

Key qualifications: Analytical and methodological competence; selection and confident use of appropriate methods; ability to expand existing knowledge independently; skill in presenting and documenting ideas, concepts and results in a comprehensible manner; self-reflection

Workload:
Total: 150 h
90 h studying of course content through exercises / case studies (self-study)
60 h internship / practical course (attendance)

Conditions:
none

Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Programming Parallel Embedded Systems
Mode of Instruction: internship
Language: German / English
Contact Hours: 4

Contents:
In the practical module, essential techniques to develop software projects in an industry-typical programming language are investigated, as well as methods for code-analysis, and for testing and debugging. Special focus is on programming parallel and concurrent applications with tasks and threads for single- and multi-core processors, and on programming with GPGPUs. Platform-independent programming is demonstrated on different systems, from 8 bit microcontrollers to 64 bit workstations, while the effects of the instruction set architecture on the performance of the software are analysed, and the resulting potential performance optimisations are evaluated. After the introduction into the essential features of the programming language, the typically used tools, was well as relevant parallel data structures, the students implement a parallel application in a larger project.

Examination
Praktikum Programming Parallel Embedded Systems
practical exam

Module INF-0436: Project Module Quantum Algorithms *Projektmodul Quantenalgorithmen*	10 ECTS/LP
Version 1.0.0 (since SoSe23) Person responsible for module: Prof. Dr. Jakob Siegfried Kottmann	

Learning Outcomes / Competences:
Nach der Teilnahme am Projektmodul verstehen die Studierenden Problemstellungen höherer Komplexität auf dem Gebiet der Quantenalgorithmen und verfügen dort über tiefergehende Fachkenntnisse und Fähigkeiten. Sie können Konzepte, Methoden, Verfahren, Techniken und Technologien des genannten Gebiets in Forschungsprojekten entwickeln und sind fähig, innovative Methoden bei der Lösung von Problemen anzuwenden. Dadurch ist es ihnen möglich, an die internationale Forschung anzuknüpfen und ihren eigenen wissenschaftlichen Beitrag auf diesem Gebiet zu leisten. Darüber hinaus verfügen die Studierenden über die Team- und Kommunikationsfähigkeit, die Fähigkeit zur Literaturrecherche und die wissenschaftliche Methodik, um Problemstellungen auf dem Gebiet zu diskutieren, Zwischenziele zu definieren, sowie Zwischenergebnisse und innovative Ideen kritisch zu bewerten, einzuordnen, zu kombinieren und zu präsentieren.

Schlüsselqualifikationen: Fertigkeit zum logischen, analytischen und konzeptionellen Denken; Eigenständige Arbeit mit englischsprachiger Fachliteratur; Verständliche, sichere und überzeugende Präsentation von Ideen, Konzepten und Ergebnissen; Qualitätsbewußtsein; Kommunikationsfähigkeit; Fertigkeit der Zusammenarbeit in Teams und Verstehen von Teamprozessen; Grundsätze guter wissenschaftlicher Praxis; Projektmanagementfähigkeiten; Wissenschaftliche Methodik

Workload:
Total: 300 h
15 h seminar (attendance)
285 h internship / practical course (self-study)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: as needed	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projektmodul Quantenalgorithmen
Mode of Instruction: internship
Language: English / German

Contents:
Mitarbeit an aktuellen Forschungsthemen

Literature:
Aktuelle Forschungsbeiträge

Assigned Courses:

Oberseminar Quantenalgorithmik

Examination

Projektmodul Quantenalgorithmen

practical exam

Test Frequency:

when a course is offered

Module INF-0439: Seminar Quantum Algorithms (Master) *Seminar Quantum Algorithms (Master)*	4 ECTS/LP
Version 1.0.0 (since SoSe23) Person responsible for module: Prof. Dr. Jakob Siegfried Kottmann	
Contents: Im Seminar werden die Inhalte aus der Vorlesung "Quantum Algorithms" vertieft. Der parallele Besuch der Vorlesung wird empfohlen. Spezifische Themen orientieren sich an aktueller Forschung. Hierbei werden in der Vorlesung aufgegriffene Anwendungsbeispiele und Themenfelder vertieft oder neue Themenfelder erschlossen. Das Seminar eignet sich als Vorbereitung einer Abschlussarbeit im Bereicht der Quantenalgorithmik.	
Learning Outcomes / Competences: Nach dem Besuch des Seminars sind die Studierenden in der Lage, weiterführende Problemstellungen, Konzepte, Methoden, Verfahren, Techniken und Technologien auf dem Gebiet der Quantenalgorithmen selbstständig zu erarbeiten, zu analysieren und bezogen auf das individuelle Seminarthema aus dem genannten Gebiet zu bewerten. Sie verfügen über die wissenschaftliche Methodik, Kommunikationsfähigkeit und Fähigkeit zum Einsatz entsprechender Medien, um ein spezielles Thema in Wort und Schrift klar und verständlich zu präsentieren und wissenschaftlich anspruchsvolle Themenstellungen aus dem genannten Gebiet kritisch und argumentativ zu diskutieren und zu bewerten. Außerdem können sie die logischen Strukturen des Denkens und Argumentierens erkennen und zielführend einsetzen. Die Teilnehmenden können klar und verständlich formulieren und Fachinhalte frei vortragen. Sie verstehen es, einen Vortrag klar und nachvollziehbar zu strukturieren und auch bei komplexen Inhalten den Vortrag auf wesentliche Botschaften auszurichten und diese verständlich zu vermitteln. Argumentationsketten und Lösungsstrategien bei Störungen wenden sie gekonnt an. Die Studierenden verstehen es, präsent aufzutreten und souverän mit gängigen Präsentationsmedien umzugehen und diese interaktiv einzusetzen. Sie schaffen es, einen Vortrag auf eine bestimmte Zielgruppe auszurichten und den Zuhörer auch bei längeren Vortragsdauern zu motivieren und verschiedene Moderationstechniken anzuwenden. **Schlüsselqualifikationen:** Literaturrecherche; Eigenständiges Arbeiten mit englischsprachiger Fachliteratur; Analytisch-methodische Kompetenz; Wissenschaftliche Methodik; Grundsätze guter wissenschaftlicher Praxis; Fertigkeit der verständlichen, sicheren und überzeugenden (schriftlichen und mündlichen) Darstellung von (praktischen oder theoretischen) Ideen, Konzepten und Ergebnissen und zu deren Dokumentation; Fertigkeit zum logischen, abstrakten, analytischen und konzeptionellen Denken und formaler Argumentation; Qualitätsbewußtsein, Akribie; Kommunikationsfähigkeit; Zeitmanagement; Bewertung von Lösungsansätzen, Verfahren, Techniken und Technologien unter unterschiedlichen Gesichtspunkten	
Workload: Total: 120 h 90 h preparation of written term papers (self-study) 30 h seminar (attendance)	

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Quantum Algorithms (Master)
Mode of Instruction: seminar
Language: English / German
Contact Hours: 2

Contents:
Die Themen des Seminars werden jedes Mal neu festgelegt und aktuellen Entwicklungen angepasst.

Literature:
Abhängig vom gewählten Thema

Assigned Courses:

Seminar Quantum Algorithms (Master) (seminar)

Examination
Seminar Quantum Algorithms (Master)
written/oral exam
Test Frequency:
when a course is offered

Module INF-0440: Quantum Algorithms *Quantum Algorithms*	5 ECTS/LP
Version 1.0.0 (since SoSe23) Person responsible for module: Prof. Dr. Jakob Siegfried Kottmann	

Learning Outcomes / Competences:
Die Studierenden erwerben Grundkenntnisse in der Quantenalgorithmik und sind in der Lage fundamentale Prinzipien zu erklären und Ihre Verwendung in algorithmischen Strukturen zu beschreiben. Sie können etablierte algorithmische Strukturen aus dem Bereich der Quantenalgorithmik, wie die Suche, Fouriertransform, und Phasenabschätzung, beschreiben und potentielle Anwendungsgebiete bestimmen und vergleichen. Nach Besuch der Veranstaltung sind Sie in der Lage quantenalgorithmische Ansätze zu konstruieren und in diskrete Operationen auf Qubitsysteme zu übersetzen. Die Studierenden haben fundiertes Basiswissen in grundlegenden quantenalgorithmische Strukturen und variationellen Heuristiken. Sie sind in der Lage quantenalgorithmische Elemente in gegenwärtiger Literatur zu identifizieren, zu analysieren und zu bewerten.

Schlüsselqualifikationen: Abstraktionsfähigkeit; Sicherer Umgang mit mathematischen Strukturen; Algorithmisches Denken; Eigenständiges Erarbeiten von algorithmischen Lösungsansätzen; Grundlegendes Verständnis für die Funktion von Quantenrechnern; Grundsätze guter wissenschaftlicher Praxis;

Workload:
Total: 150 h
60 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)
15 h studying of course content using provided materials (self-study)
30 h exercise course (attendance)
30 h lecture (attendance)

Conditions:	**Credit Requirements:**
Grundkenntnisse in linearer Algebra werden empfohlen.	Bestehen der Modulprüfung.

Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Quantum Algorithms (Vorlesung)
Mode of Instruction: lecture
Language: English / German
Contact Hours: 2

Contents:

Foundations of Quantum Information Processing:

- qubits and their representation
- BraKet notation and necessary structures from linear algebra
- operations on qubits: circuits and gates

Quantum Algorithms

- quantum search and amplitude amplification
- quantum fourier transform and it's applications
- quantum simulation
- variational quantum algorithms
- differentiable quantum algorithmic procedures
- quantum heuristics
- usecases from current day research

Literature:

Basics of Quantum Information/Quantum Computation:

- Michal Nielsen; Isaac Chuang: Quantum Computation and Quantum Information

Basics of quantum mechanics:

- Richard P. Feynman; Robert B. Leighton; Matthew Sands: Feynman-Vorlesungen über Physik: Band III, Quantenmechanik
- original scripts are online: https://www.feynmanlectures.caltech.edu/info/

Overview over variational quantum algorithms:

- https://doi.org/10.1103/RevModPhys.94.015004
- https://doi.org/10.1038/s42254-021-00348-9

More on quantum algorithms:

- http://theory.caltech.edu/~preskill/ph229/ (chapter 5 provides a good summary of the well-known "traditional" quantum algorithms)

Assigned Courses:

Quantum Algorithms (lecture)

Part of the Module: Quantum Algorithms (Übung)
Mode of Instruction: exercise course
Language: English
Contact Hours: 2

Assigned Courses:

Übung zu Quantum Algorithms (exercise course)

Examination
Quantum Algorithms
oral exam / length of examination: 25 minutes
Test Frequency:
when a course is offered

Module INF-0441: Practical Module Natural Language Processing *Praktikum Natural Language Processing*	5 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Björn Schuller

Learning Outcomes / Competences:
The Natural Language Processing (NLP) Praktikum is focussed on the practical application of machine learning, in particular, deep learning methods to textual data.
After completing the Praktikum, students will have acquired an understanding of the different challenges when dealing with natural language text data. They will have an overview over the most important problems in NLP and the considerable recent progress in this field as facilitated by large Language Models. They have gained insight into the inner workings, advantages and disadvantages of state-of-the-art models and first experiences in applying them to address various problems.
During this hands-on course, the students will strengthen their abilities in analytical thinking and programming. They will deepen their knowledge of machine learning and will be able to transfer and connect their knowledge to the domain of textual data. Students will gain the prerequisites necessary to keep up with current and future developments in this highly dynamic and impactful field, being able to weigh the merits and downsides of contemporary NLP methods.
Key qualifications: analytical skills, knowledge about machine learning for NLP, relating existing knowledge to a specific application domain, ability to present and document results in a comprehensible way, skill to solve problems under practical conditions, self-reflection, quality awareness, meticulousness, teamwork

Workload:
Total: 150 h
60 h internship / practical course (attendance)
90 h studying of course content through exercises / case studies (self-study)

Conditions:		**Credit Requirements:**
Module Deep Learning (INF-0315) - recommended		Bestehen der Modulprüfung
Frequency: irregular (usu. winter semester)	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Natural Language Processing
Mode of Instruction: internship
Language: English
Contact Hours: 4

Contents:
Neural Networks, Machine Learning, Word Embeddings, Transformers, Transfer Learning, Finetuning, Text Preprocessing, Text Classification, Natural Language Generation, Few-Shot Learning

Literature:
Wird vom Dozenten / von der Dozentin bekannt gegeben

Assigned Courses:

Praktikum Natual Language Processing (internship)

Examination

Praktikum Natural Language Processing

practical exam

Module INF-0443: Seminar on Theory of distributed and parallel Systems (Master) *Seminar Theorie verteilter und paralleler Systeme (Master)*	4 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Kirstin Peters

Learning Outcomes / Competences:
Nach dem Besuch des Seminars sind die Studierenden in der Lage, weiterführende Problemstellungen, Konzepte, Methoden, Verfahren, Techniken und Technologien auf dem Gebiet der Theorie verteilter und paralller Systeme selbstständig zu erarbeiten, zu analysieren und bezogen auf das individuelle Seminarthema aus dem genannten Gebiet zu bewerten.
Sie verfügen über die wissenschaftliche Methodik, Kommunikationsfähigkeit und Fähigkeit zum Einsatz entsprechender Medien, um ein spezielles Thema in Wort und Schrift klar und verständlich zu präsentieren und wissenschaftlich anspruchsvolle Themenstellungen aus dem genannten Gebiet kritisch und argumentativ zu diskutieren und zu bewerten. Außerdem können sie die logischen Strukturen des Denkens und Argumentierens erkennen und zielführend einsetzen.
Die Teilnehmenden können klar und verständlich formulieren und Fachinhalte frei vortragen. Sie verstehen es, einen Vortrag klar und nachvollziehbar zu strukturieren und auch bei komplexen Inhalten den Vortrag auf wesentliche Botschaften auszurichten und diese verständlich zu vermitteln. Argumentationsketten und Lösungsstrategien bei Störungen wenden sie gekonnt an.
Die Studierenden verstehen es, präsent aufzutreten und souverän mit gängigen Präsentationsmedien umzugehen und diese interaktiv einzusetzen. Sie schaffen es, einen Vortrag auf eine bestimmte Zielgruppe auszurichten und den Zuhörer auch bei längeren Vortragsdauern zu motivieren und verschiedene Moderationstechniken anzuwenden.

Schlüsselqualifikationen: Literaturrecherche; Eigenständiges Arbeiten mit englischsprachiger Fachliteratur; Analytisch-methodische Kompetenz; Wissenschaftliche Methodik; Grundsätze guter wissenschaftlicher Praxis; Fertigkeit der verständlichen, sicheren und überzeugenden (schriftlichen und mündlichen) Darstellung von (praktischen oder theoretischen) Ideen, Konzepten und Ergebnissen und zu deren Dokumentation; Fertigkeit zum logischen, abstrakten, analytischen und konzeptionellen Denken und formaler Argumentation; Qualitätsbewußtsein, Akribie; Kommunikationsfähigkeit; Zeitmanagement; Bewertung von Lösungsansätzen, Verfahren, Techniken und Technologien unter unterschiedlichen Gesichtspunkten

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Theorie verteilter und paralleler Systeme (Master)
Mode of Instruction: seminar
Language: German
Frequency: irregular
Contact Hours: 2

Contents:

Die Themen des Seminars werden jedes Mal neu festgelegt und an aktuelle Entwicklungen angepasst.

Literature:

Abhängig vom gewählten Thema

Examination

Seminar Theorie verteilter und paralleler Systeme (Master)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0444: Seminar Generative Artificial Intelligence *Seminar Generative Künstliche Intelligenz*	4 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Elisabeth André

Learning Outcomes / Competences:
After attending the seminar, students are able to independently work out, analyze and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of "Generative Artificial Intelligence" in relation to the individual seminar topic from the mentioned field. They have the scientific methodology, communication skills and ability to use appropriate media to present a specific topic clearly and comprehensibly, both verbally and in writing, and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively. They will also be able to recognize the logical structures of reasoning and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present specialist content freely. They understand how to structure a lecture in a clear and comprehensible way and how to focus the lecture on essential messages and convey them in a comprehensible way, even in the case of complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to present themselves and how to deal confidently with common presentation media and to use them interactively. They manage to gear a lecture to a specific target group and to motivate the listener even during longer lecture durations and to apply various moderation techniques.

Key qualifications: Literature research; Independent work with English-language specialist literature; Analytical-methodical competence; Scientific methodology; Principles of good scientific practice; Skill in the comprehensible, confident and convincing (written and oral) presentation of (practical or theoretical) ideas, concepts and results and for their documentation; Skill in logical, abstract, analytical and conceptual thinking and formal argumentation; Quality awareness, meticulousness; Communication skills; Time management.

Workload:
Total: 120 h
30 h seminar (attendance)
90 h preparation of written term papers (self-study)

Conditions:
none

Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Generative Artificial Intelligence
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:
Topics in the field of "Generative Artificial Intelligence"

Literature:
References will be announced at the preliminary meeting.

Assigned Courses:

Seminar Generative Künstliche Intelligenz (seminar)

Examination

Seminar Generative Artificial Intelligence

written/oral exam

Module INF-0446: Seminar Software and Artificial Intelligence for Production Systems (Master) *Seminar Software und Künstliche Intelligenz in der Produktion (Master)*	4 ECTS/LP
Version 1.0.0 (since SoSe23) Person responsible for module: Prof. Dr. Wolfgang Reif	

Learning Outcomes / Competences:

After successful completion of the seminar, students are able to understand, to learn, to analyse and evaluate advanced problems, concepts, methods, procedures, techniques and technologies in the field of software and systems engineering.

They known the scientific methods, communication skills and the ability to use appropriate media to present a specific topic clearly and comprehensibly in speech and writing and to discuss challenging scientific topics from the aforementioned field critically. They will also be able to recognize the logical structures of reasoning and argumentation and use them.

The participants are able to formulate clearly and understandably and to present specialist knowledge freely. They understand how to structure a presentation in a clear and comprehensible way and how to focus the presentation on the core messages and convey them in a comprehensible way even for complex and advanced subjects.

Die Studierenden verstehen es, präsent aufzutreten und souverän mit gängigen Präsentationsmedien umzugehen und diese interaktiv einzusetzen. Sie schaffen es, einen Vortrag auf eine bestimmte Zielgruppe auszurichten und den Zuhörer auch bei längeren Vortragsdauern zu motivieren und verschiedene Moderationstechniken anzuwenden.

The students understand how to present themselves and how to deal confidently with common presentation media. They manage to focus a presentation to a specific target group and to motivate the audience and they have working knowledge of moderation techniques to guide a discussion.

Soft Skills:

- Literature research
- Independently work with English technical literature
- Analytical competence
- Working methodical
- Principles of good scientific practice
- Ability to present (written and oral) ideas, concepts and results in a comprehensible and convincing manner and to document them
- Ability to think logically, abstractly, analytically and conceptually and to argue precisely
- Awareness for quality aspects
- Communication skills
- Time management
- Evaluation of solution approaches, procedures, techniques and technologies from different points of view

Workload:

Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		
Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Software und Künstliche Intelligenz in der Produktion (Master)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2

Contents:

The topics of the seminar deal wtih current trends in Software and Systems Engineering on the level of graduate students. The topics change from year to year and are regulary adapted to reflect new developments.

Literature:

Depends on the concrete topic.

Assigned Courses:

Seminar zu Software und Künstliche Intelligenz in der Produktion (Master) (seminar)

Examination

Seminar Software und Künstliche Intelligenz in der Produktion (Master)

written/oral exam / length of examination: 45 minutes

work period for assignment: 3 months

Test Frequency:

when a course is offered

Module INF-0448: Seminar on Concurrent Systems (Master) *Seminar zu nebenläufigen Systemen (Master)*	4 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Robert Lorenz

Learning Outcomes / Competences:
After attending the seminar, the students can independently work out and analyse advanced problems, concepts, methods, procedures, techniques, and technologies from the field of digital ethics and evaluate them in relation to the individual seminar topic.

Participants possess scientific methodology, communication skills, and the ability to present a special topic clearly and comprehensibly in speech and writing and to discuss and evaluate scientifically challenging topics from the named field critically and argumentatively.

Furthermore, they learn to recognise logical structures of thinking and argumentation and use them in a goal-oriented manner. The participants can formulate clearly and comprehensibly and present subject content freely. They understand how to structure a talk that is clear and easy to follow. Additionally, the students know how to focus on essential messages and convey them in a comprehensible way, even with complex content. They skilfully apply chains of argumentation and solution strategies in the event of disruptions. The students understand how to confidently deal with common presentation media and use them interactively. They manage to gear a talk to a specific target group, apply various moderation techniques, and keep their audience engaged even over a longer period.

Key qualifications: Presentation techniques; literature research; principles of good scientific practice; evaluating solution approaches, procedures, techniques, and technologies from different points of view.

Workload:
Total: 120 h
90 h preparation of presentations (self-study)
30 h seminar (attendance)

Conditions: Module Process Mining (INF-0243) - recommended		**Credit Requirements:** Passing the module examination
Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Digital Ethics (Master)
Mode of Instruction: seminar
Language: English / German
Contact Hours: 2
ECTS Credits: 4.0

Contents:
The topics of the seminar change over time, in order to reflect up-to-date developments

Literature:
Literature depends on the chosen topic

Assigned Courses:

Seminar zu Secure Coding (seminar)

Examination

Seminar Digital Ethics (Master)

written/oral exam

Test Frequency:

when a course is offered

Module INF-0450: Clinical Research Data Management *Klinisches Forschungsdatenmanagement*	5 ECTS/LP
Version 1.0.0 (since SoSe23) Person responsible for module: Prof. Dr. Frank Kramer Yevgeniia Ignatenko	
Learning Outcomes / Competences: Die Studierenden erwerben ein Grundverständnis des Datenlaufkreis in der klinischen Forschung; Anwendungsverständnis von Erstellen von Formularen für Patientenumfragen; Fähigkeit zur selbstständigen Konzipierung und Erstellen eines minimalen Datensatzes und eigener FHIR- Ressource für eine medizinische Studie; Praktisches Verständnis Extraktions-, Transformations- und Ladeprozessen bei der Datenbereitstellung für die Forschung; Evaluation und Auswertungsmöglichkeiten der erhobenen Daten durch Machbarkeitsabfragen. Darüber hinaus erweitern sie ihre Kompetenzen in den Bereichen Team- und Kommunikationsfähigkeit sowie Selbstorganisation durch die Bearbeitung von Aufgaben. **Schlüsselqualifikationen:** Fertigkeit zum logischen, analytischen und konzeptionellen Denken; Eigenständiges Arbeiten mit Lehrbüchern und wissenschaftlicher Fachliteratur, Konfiguration und Anwendung der bereitgestellten Softwaretools; Problemlösungskompetenz.	
Workload: Total: 150 h 30 h lecture (attendance) 30 h exercise course (attendance) 15 h studying of course content using literarture (self-study) 60 h studying of course content through exercises / case studies (self-study) 15 h studying of course content using provided materials (self-study)	
Conditions: Module IT Infrastructure in Medical Information Systems (INF-0312) - recommended	**Credit Requirements:** Passing the module exam

Frequency: irregular	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 4	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module
Part of the Module: Klinisches Forschungsdatenmanagement (Vorlesung) **Mode of Instruction:** lecture **Language:** German / English **Contact Hours:** 2

Contents:

Die Vorlesung behandelt aktuelle Themen im Kontext von Forschungsdatenmanagement.
Dazu zählen folgende Inhalte:

- Einführung in das Forschungsdatenmanagement
- Datenmanagementplan
- Der Lebenszyklus von Forschungsdaten
- ETL
- Datenverarbeitung, Datenanalyse und -Visualisierung
- Metadaten
- Datenspeicherung und -archivierung. Forschungsdaten-Repositorien
- Rechtliche Grundlagen

Literature:

- Handbuch der Medizinischen Informatik, Thomas M. Lehmann, 2. Auflage, 2014
- Biomedizinische Ontologie: Wissen strukturieren für den Informatik-Einsatz, Ludger Jamsem, Barry Smith (Hrsg.), 2008

Assigned Courses:

Klinisches Forschungsdatenmanagement (lecture)

Part of the Module: Klinisches Forschungsdatenmanagement (Übung)
Mode of Instruction: exercise course
Language: German / English
Contact Hours: 2

Assigned Courses:

Übung zu Klinisches Forschungsdatenmanagement (exercise course)

Examination
Klinisches Forschungsdatenmanagement
portfolio exam
Test Frequency:
when a course is offered

Module INF-0453: Seminar Diagnostic Sensing (Master) *Seminar Diagnostische Sensorik (Master)*	4 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Sebastian Zaunseder

Learning Outcomes / Competences:
Nach dem Besuch des Seminars sind die Studierenden in der Lage, grundlegende Problemstellungen, Konzepte, Methoden, Verfahren, Techniken und Technologien auf dem Gebiet der Diagnostischen Sensorik selbstständig zu erarbeiten und zu verstehen.
Sie verfügen über die Arbeitstechniken, Kommunikationsfähigkeit und Fähigkeit zum Einsatz entsprechender Medien, um ein spezielles Thema in Wort und Schrift klar und verständlich zu präsentieren und Themenstellungen aus dem genannten Gebiet kritisch und argumentativ zu diskutieren. Außerdem können sie die logischen Strukturen des Denkens und Argumentierens erkennen und zielführend einsetzen.
Die Teilnehmenden können klar und verständlich formulieren und Fachinhalte frei vortragen. Sie verstehen es, einen Vortrag klar und nachvollziehbar zu strukturieren und den Vortrag auf wesentliche Botschaften auszurichten und diese verständlich zu vermitteln.
Die Studierenden verstehen es, präsent aufzutreten und souverän mit gängigen Präsentationsmedien umzugehen. Sie schaffen es, einen Vortrag auf eine bestimmte Zielgruppe auszurichten und den Zuhörer zu motivieren und verschiedene Moderationstechniken anzuwenden.

Schlüsselqualifikationen: Literaturrecherche; Eigenständiges Arbeiten mit englischsprachiger Fachliteratur; Analytisch-methodische Kompetenz; Wissenschaftliche Methodik; Grundsätze guter wissenschaftlicher Praxis; Fertigkeit der verständlichen, sicheren und überzeugenden (schriftlichen und mündlichen) Darstellung von (praktischen oder theoretischen) Ideen, Konzepten und Ergebnissen und zu deren Dokumentation; Fertigkeit zum logischen, abstrakten, analytischen und konzeptionellen Denken und formaler Argumentation; Qualitätsbewußtsein, Akribie; Kommunikationsfähigkeit; Zeitmanagement

Workload:
Total: 120 h
90 h preparation of written term papers (self-study)
30 h seminar (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: irregular	**Recommended Semester:**	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 2	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Seminar Diagnostische Sensorik (Master)
Mode of Instruction: seminar
Language: German / English
Contact Hours: 2
ECTS Credits: 4.0

Contents:
Die Themen des Seminars werden jedes Mal neu festgelegt und aktuellen Entwicklungen angepasst.

Literature:
Abhängig vom gewählten Thema

Assigned Courses:

Seminar Diagnostische Sensorik (Master) (seminar)

Examination

Seminar Diagnostische Sensorik (Master)

Test Frequency:

when a course is offered

Module INF-0454: Practical Module Diagnostic Sensing (Master) *Praktikum Diagnostische Sensorik (Master)*	10 ECTS/LP

Version 1.0.0 (since SoSe23)
Person responsible for module: Prof. Dr. Sebastian Zaunseder

Learning Outcomes / Competences:
Subject-specific competencies:

Students acquire in-depth knowledge with respect to a specific topic related to medical sensing or sensor data analysis.

Methodological competencies:

Students are able to plan, organize and perform research independently. They can select, understand and condense scientific literature. They acquire deepened knowledge on complex algorithmic solutions as it concerns its theoretical background and its practical implementation. Students are familiar with statistical methods and have the skills to apply them in practice.

Cross-disciplinary competencies:

The acquired competencies are basis for familiarization with novel topics and basic requirement for other scientific works.

Key qualifications:

Ability to think logically, analytically, and conceptually; independent research using textbooks, scientific works, manuals, and documentation; presentation of ideas, concepts, and results in an understandable, confident, and persuasive manner; awareness of quality; communication skills; ability to work in teams and understand team processes; knowledge of practical tasks

Workload:
Total: 300 h
15 h seminar (attendance)
285 h internship / practical course (self-study)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each semester	**Recommended Semester:**	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Praktikum Diagnostische Sensorik (Master)
Mode of Instruction: internship
Language: German / English
Contact Hours: 1
ECTS Credits: 10.0

Contents:

Students work on a current research project related to sensing or sensor data analysis. The tasks to be performed by students typically comprise literature review, practical parts (programming, data acquisition, commissioning), (quantitative) evaluation, documentation and presentation. According to the research foci of the professorship, there are different areas for topics to choose from:

- experimental works related to innovative sensing modalities
- development and evaluation of methods for intelligent patient monitoring
- development and evaluation of methods to predict severe complications from multimodal sensor data
- development and characterization of novel methods for sensor data fusion
- application of machine learning for sensor data processing

Literature:

Depending on the selected topic

Assigned Courses:

Praktikum Diagnostische Sensorik (Master) (internship)

Examination

Praktikum Diagnostische Sensorik (Master)

portfolio exam

Test Frequency:

when a course is offered

Module INF-0455: Project Module Diagnostic Sensing *Projektmodul Diagnostische Sensorik*	10 ECTS/LP
Version 1.0.0 (since SoSe23) Person responsible for module: Prof. Dr. Sebastian Zaunseder	

Learning Outcomes / Competences:
Nach der Teilnahme am Projektmodul verstehen die Studierenden Problemstellungen höherer Komplexität auf dem Gebiet der diagnostischen Sensorik und verfügen dort über tiefergehende Fachkenntnisse und Fähigkeiten. Sie können Konzepte, Methoden, Verfahren, Techniken und Technologien des genannten Gebiets in Forschungsprojekten entwickeln und sind fähig, innovative Methoden bei der Lösung von Problemen anzuwenden. Dadurch ist es ihnen möglich, an die internationale Forschung anzuknüpfen und ihren eigenen wissenschaftlichen Beitrag auf diesem Gebiet zu leisten. Darüber hinaus verfügen die Studierenden über die Team- und Kommunikationsfähigkeit, die Fähigkeit zur Literaturrecherche und die wissenschaftliche Methodik, um Problemstellungen auf dem Gebiet zu diskutieren, Zwischenziele zu definieren, sowie Zwischenergebnisse und innovative Ideen kritisch zu bewerten, einzuordnen, zu kombinieren und zu präsentieren.

Schlüsselqualifikationen: Fertigkeit zum logischen, analytischen und konzeptionellen Denken; Eigenständige Arbeit mit englischsprachiger Fachliteratur; Verständliche, sichere und überzeugende Präsentation von Ideen, Konzepten und Ergebnissen; Qualitätsbewußtsein; Kommunikationsfähigkeit; Fertigkeit der Zusammenarbeit in Teams und Verstehen von Teamprozessen; Grundsätze guter wissenschaftlicher Praxis; Projektmanagementfähigkeiten; Wissenschaftliche Methodik

Workload:
Total: 300 h
285 h internship / practical course (self-study)
15 h seminar (attendance)

Conditions: none		**Credit Requirements:** Bestehen der Modulprüfung
Frequency: each semester	**Recommended Semester:**	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 1	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Projektmodul Diagnostische Sensorik
Mode of Instruction: internship
Language: German / English
Contact Hours: 1

Contents:
Aktuelle Forschungsthemen

Literature:
Wissenschaftliche Aufsätze

Assigned Courses:

Oberseminar Diagnostische Sensorik

Examination

Projektmodul Diagnostische Sensorik

practical exam

Test Frequency:

when a course is offered

Module INF-0456: Content Creation for Virtual Environments *Content Creation for Virtual Environments*	8 ECTS/LP
Version 1.0.0 (since SoSe23) Person responsible for module: Prof. Dr. Elisabeth André	

Learning Outcomes / Competences:
After successful completion of this module, students will understand essential concepts and techniques for making and integrating 2D/3D graphics and audio for virtual environments. They have the knowledge of the mindset and language of application-relevant disciplines. Within the framework of the lecture, they learn to create content by hand and generatively with procedural methods and algorithms, taking into account design principles, to integrate the content into applications, to develop algorithms independently and to implement them technically. The skills of confident and convincing presentation of ideas and concepts, comprehensible presentation and documentation of results, as well as creative, aesthetic, musical, logical, analytical and conceptual thinking are also particularly promoted within this framework.

Key Qualifications: Aesthetic, design, artistic, and musical fundamentals, design of virtual worlds, selection and confident application of appropriate methods, interdisciplinary knowledge, skill in analyzing and structuring complex computer science problems, skill in developing and implementing solution strategies for complex problems, understanding of team processes, skill in working in teams, self-reflection; acting responsibly in the face of inadequacy and conflicting interests, quality awareness, meticulousness.

Workload:
Total: 240 h
60 h exercise course (attendance)
30 h lecture (attendance)
15 h studying of course content using provided materials (self-study)
120 h studying of course content through exercises / case studies (self-study)
15 h studying of course content using literarture (self-study)

Conditions: none		
Frequency: each summer semester	**Recommended Semester:** from 1.	**Minimal Duration of the Module:** 1 semester[s]
Contact Hours: 6	**Repeat Exams Permitted:** according to the examination regulations of the study program	

Parts of the Module

Part of the Module: Content Creation for Virtual Environments (Lecture)
Mode of Instruction: lecture
Language: German / English
Contact Hours: 2

Assigned Courses:

Content Creation for Virtual Environments (lecture)

Part of the Module: Content Creation for Virtual Environments (Exercise Course)
Mode of Instruction: exercise course
Language: German / English
Contact Hours: 4

Assigned Courses:

Übung zu Content Creation for Virtual Environments (exercise course)

Examination

Content Creation for Virtual Environments

portfolio exam