



UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

# Master Media Informatics 2020



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PY2300-KP06 - Basics in statistics 2 (Statistik2)		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 6
<b>Course of study, specific field and term:</b>		
<ul style="list-style-type: none"> <li>• Bachelor Psychology 2027 (compulsory), psychology, 2nd semester</li> <li>• Master Media Informatics 2014 (optional subject), mathematics, Arbitrary semester</li> <li>• Master Media Informatics 2020 (optional subject), mathematics, Arbitrary semester</li> <li>• Bachelor Psychology 2020 (compulsory), psychology, 2nd semester</li> <li>• Bachelor Psychology 2016 (compulsory), psychology, 3rd semester</li> </ul>		
<b>Classes and lectures:</b>		<b>Workload:</b>
<ul style="list-style-type: none"> <li>• Basics of statistics 2 (lecture, 2 SWS)</li> <li>• Basics of statistics 2 (seminar, 2 SWS)</li> </ul>		<ul style="list-style-type: none"> <li>• 120 Hours private studies and exercises</li> <li>• 60 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b>		
<ul style="list-style-type: none"> <li>• Analysis of Variance (ANOVA)</li> <li>• General linear model, incl. simple and multiple regression, outlier testing</li> <li>• Relationship of ANOVA and Regression</li> <li>• Robust testing</li> <li>• Basics of non-parametric testing</li> <li>•</li> </ul>		
<b>Qualification-goals/Competencies:</b>		
<ul style="list-style-type: none"> <li>• Mastering and judging basic concepts and techniques in analysis of variance and regression</li> <li>• Students should be familiar with more complex but application-relevant concepts and methods such as power calculation, non-parametric methods or multiple comparisons and be able to critically assess them</li> <li>• Experience in working with statistical software packages</li> <li>• Acquisition of skills in the use of a statistics program (e.g. R, JAMOVI, JASP)</li> <li>• Ability to interpret statistical results appropriately and independently</li> </ul>		
<b>Grading through:</b>		
<ul style="list-style-type: none"> <li>• written exam</li> </ul>		
<b>Is requisite for:</b>		
<ul style="list-style-type: none"> <li>• Experimental Psychology (PY2800-KP06)</li> </ul>		
<b>Requires:</b>		
<ul style="list-style-type: none"> <li>• Statistics 1 (PY1800-KP06)</li> </ul>		
<b>Responsible for this module:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. nat. Jonas Obleser</a></li> </ul>		
<b>Teacher:</b>		



- Department of Psychology
- Prof. Dr. rer. nat. Jonas Obleser
- PD Dr. phil. Sarah Tune
- PD Dr. rer. nat. Malte Wöstmann

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**Literature:**

- Eid, M., Gollwitzer, M. & Schmitt, M.: Statistik und Forschungsmethoden - Beltz. 1. Auflage, 2010
- Wirtz, M., Nachtigall, C.: Wahrscheinlichkeitsrechnung und Inferenzstatistik. Statistische Methoden für Psychologen Teil 2 - Beltz Juventa. 6. Auflage, 2012

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**Language:**

- offered only in German

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**Notes:**

Admission requirements for taking the module:  
- None

Admission requirements for participation in module examination(s):  
- at least 50% of the stock Quizzes

Module examination(s):  
- PY2300-L1: Statistics 2, written exam, 90min, 100% of the module grade

**CS4020-KP06, CS4020SJ14 - Specification and Modelling (SpezMod14)**
**Duration:**

1 Semester

**Turnus of offer:**

each summer semester

**Credit points:**

6

**Course of study, specific field and term:**

- Master Media Informatics 2020 (optional subject), computer science, 3rd semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (basic module), Theoretical computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (optional subject), Theoretical computer science, 1st or 2nd semester
- Master IT-Security 2019 (compulsory), Theoretical computer science, 1st or 2nd semester
- Master Medical Informatics 2014 (basic module), computer science, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), technology field computer science, 1st or 2nd semester
- Master Computer Science 2014 (optional subject), specialization field IT security and safety, 2nd or 3rd semester
- Master Computer Science 2014 (basic module), Theoretical computer science, 1st or 2nd semester

**Classes and lectures:**

- Specification and Modelling (lecture, 2 SWS)
- Specification and Modelling (exercise, 2 SWS)

**Workload:**

- 80 Hours private studies and exercises
- 60 Hours in-classroom work
- 20 Hours exam preparation
- 20 Hours work on project

**Contents of teaching:**

- Introduction to modelling and specification
- Modelling concepts (data, streams, traces, diagrams, tables)
- Modelling software components (state, behaviour, structure, interface)
- Modelling concurrency
- Algebraic specification
- Composing, refining, analysing and transforming specifications and models
- Specification languages and tools for specification and modelling

**Qualification-goals/Competencies:**

- The students can argue on the importance of specifications and models for software development.
- They can characterize, apply, adapt and extend important specification and modelling techniques.
- They can model and specify simple software/hardware system in an adequate way.
- They can describe a system from different views and on different levels of abstraction.
- They can apply specifications and models in software development.
- They can analyse specifications and models.

**Grading through:**

- Written or oral exam as announced by the examiner

**Responsible for this module:**

- [Prof. Dr. Martin Leucker](#)

**Teacher:**

- [Institute of Software Technology and Programming Languages](#)
- [Dr. Annette Stümpel](#)
- [Prof. Dr. Martin Leucker](#)

**Literature:**

- V.S. Alagar, K. Periyasamy: Specification of Software Systems - Springer 2013
- M. Broy, K. Stølen: Specification and Development of Interactive Systems - Springer 2001
- J. Loeckx, H.-D. Ehrich, M. Wolf: Specification of Abstract Data Types - John Wiley & Sons 1997
- D. Bjorner: Software Engineering 1-3 - Springer 2006
- U. Kastens, H. Kleine Büning: Modellierung - Grundlagen und formale Methoden - Hanser 2005



**Language:**

- German and English skills required

**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercises as specified at the beginning of the semester.

Module Examination(s):

- CS4020-L1: Specification and Modeling, written exam, 90min, 100% of the module grade.

**CS4130-KP06, CS4130 - Information Systems (InfoSys)**
**Duration:**

1 Semester

**Turnus of offer:**

each summer semester

**Credit points:**

6

**Course of study, specific field and term:**

- Master Computer Science 2019 (compulsory), Canonical Specialization Data Science and AI, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (basic module), Applied computer science, 1st or 2nd semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester
- Master IT-Security 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Medical Informatics 2014 (basic module), ehealth / infomatics, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), Applied computer science, 1st or 2nd semester
- Master Computer Science 2014 (optional subject), specialization field software systems engineering, 2nd or 3rd semester
- Master Computer Science 2014 (basic module), Applied computer science, 1st or 2nd semester

**Classes and lectures:**

- Information Systems (lecture, 2 SWS)
- Information Systems (exercise, 2 SWS)

**Workload:**

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Motivation of knowledge graphs and their relationship to the Semantic Web
- Overview over the W3C Semantic Web family of languages
- Comparison between and the interaction of knowledge graphs and generative artificial intelligence such as large language models
- Graph Neural Networks and their applications for tasks of knowledge graphs

**Qualification-goals/Competencies:**

- Knowledge: Students acquire an overview of knowledge graphs and the Semantic Web as well as generative artificial intelligence such as large language models and graph neural networks.
- Skills: Students can assess the possibilities and limitations of knowledge graphs and the Semantic Web. They can estimate the consequences of the Semantic Web approach for data modeling, data administration and processing and for applications. They can develop Semantic Web applications. They can use generative artificial intelligence such as large language models and graph neural networks to solve tasks for and in addition to knowledge graphs. They can discuss open research questions in the area of knowledge graphs and the semantic web as well as in comparison to generative artificial intelligence and graph neural networks.
- Social skills and independence: Students work in groups to complete exercises and small projects. Students' independent practical work is encouraged through exercises, some of them directly on the computer.

**Grading through:**

- Written or oral exam as announced by the examiner

**Responsible for this module:**

- [Prof. Dr. Sven Groppe](#)

**Teacher:**

- [Institute of Information Systems](#)
- [Prof. Dr. Sven Groppe](#)

**Literature:**

- M. Kejriwal, C. Knoblock: Knowledge graphs - MIT Press, 2021
- S. Groppe: Data Management and Query Processing in Semantic Web Databases - Springer, 2011
- W. L. Hamilton: [Graph Representation Learning. In Synthesis Lectures on Artificial Intelligence and Machine Learning - Springer International Publishing, 2020](#)
- D. Jurafsky, J. H. Martin: Speech and language processing - Upper Saddle River, NJ: Pearson, 2008
- D. Foster: Generative deep learning - Sebastopol, CA: O'Reilly Media, 2023



**Language:**

- German and English skills required

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**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercises as specified at the beginning of the semester

Module Exam(s):

- CS4130-L1: Information Systems, written exam or oral exam, 100% of module grade

Previous name: Web Based Information Systems

**CS4139-KP06, CS4139 - Runtime Verification and Testing (RVTesten)**
**Duration:**

1 Semester

**Turnus of offer:**

each summer semester

**Credit points:**

6

**Course of study, specific field and term:**

- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master IT-Security 2019 (optional subject), IT Safety and Reliability, 1st, 2nd, or 3rd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Medical Informatics 2014 (optional subject), computer science, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2014 (optional subject), specialization field IT security and safety, 1st or 2nd semester

**Classes and lectures:**

- Runtime Verification and Testing (lecture, 3 SWS)
- Runtime Verification and Testing (exercise, 1 SWS)

**Workload:**

- 100 Hours private studies and exercises
- 60 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Quality aspects of software systems
- Analysis and verification techniques for software systems
- Testing levels
- Testing process
- Kinds of tests
- Test case generation
- Specification of correctness properties
- synthesis of monitors for the observation of software systems
- diagnosis of errors in software systems
- realization of monitoring frameworks

**Qualification-goals/Competencies:**

- The students can describe and compare analysis and verification techniques.
- They can construct, analyse and evaluate specifications of correctness and safety properties.
- They can illustrate different techniques for testing hardware and software systems and can select and apply suitable techniques.
- They can explain the operation process of test case generation tools and can classify suitable applications.
- They can describe and apply techniques for the synthesis of monitors.
- With the acquired techniques they can develop software of higher quality.

**Grading through:**

- Written or oral exam as announced by the examiner

**Responsible for this module:**

- [Prof. Dr. Martin Leucker](#)

**Teacher:**

- [Institute of Software Technology and Programming Languages](#)
- [Prof. Dr. Martin Leucker](#)

**Literature:**

- G.J. Myers: The Art of Software Testing - John Wiley, 1979
- B. Beizer: Software Testing Techniques - Van Nostrand Reinhold, 1999
- M. Broy, B. Jonsson, J.-P. Katoen, M. Leucker, A. Pretschner: Model-Based Testing of Reactive Systems - Springer, 2005
- A. Bauer, M. Leucker, C. Schallhart: Runtime Verification for LTL and TLTL - ACM TOSEM, 2011
- C. Baier, J.-P. Katoen: Principles of Model Checking - MIT Press, 2008
- D. Peled: Software Reliability Methods - Springer, 2001

**Language:**



- English, except in case of only German-speaking participants

**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercises as specified at the beginning of the semester.

Module Exam(s):

- CS4139-L1: Runtime Verification and Testing, oral exam, 100% of the module grade.

**CS4140-KP04, CS4140 - Mobile and Distributed Databases (MVDB)**
**Duration:**

1 Semester

**Turnus of offer:**

each winter semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 3rd semester
- Master Computer Science 2012 (compulsory), specialization field software systems engineering, 1st semester

**Classes and lectures:**

- Mobile and Distributed Databases (lecture, 2 SWS)
- Mobile and Distributed Databases (exercise, 1 SWS)

**Workload:**

- 65 Hours private studies
- 45 Hours in-classroom work
- 10 Hours exam preparation

**Contents of teaching:**

- The contents of the lecture covers query processing, transactions and replication in
  - - centralised database management systems
  - - parallel database management systems
  - - distributed database management systems
  - - mobile database management systems

**Qualification-goals/Competencies:**

- Students can explain the differences between centralised, parallel, distributed and mobile database management systems.
- They can judge about the practical suitability of different synchronization approaches for distributed and mobile transactions for a given problem.
- They can apply approaches for distributed and mobile query processing.
- They can choose suitable replication approaches for a given application and justify their choices.
- They can recognize and deal with the special difficulties and sources of error in distributed and mobile environments.

**Grading through:**

- Oral examination

**Responsible for this module:**

- [Prof. Dr. Sven Groppe](#)

**Teacher:**

- [Institute of Information Systems](#)
- [Prof. Dr. Sven Groppe](#)

**Literature:**

- A. Kemper, A. Eickler: Datenbanksysteme - 2006
- T. Conolly, C. Begg: Database Systems - A Practical Approach to Design, Implementation, and Management - Addison-Wesley 2005
- [E. Rahm: Mehrrechner-Datenbanksysteme - Addison-Wesley 1994](#)
- P. Dadam: Verteilte Datenbanken und Client/Server Systeme - Springer 1996
- H. Höpfner, C. Türker, B. König-Ries: Mobile Datenbanken und Informationssysteme - dpunkt.verlag 2005
- B. Mutschler, G. Specht: Mobile Datenbanksysteme - Springer 2004
- V. Kumar: Mobile Database Systems - Wiley-Interscience 2006

**Language:**

- offered only in German

**Notes:**



Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Active participation in lecture and tutorial

Module Examination(s):

- CS4140-L1: Mobile and Distributed Databases, oral exam, 100% of module grade.

**CS4150-KP06, CS4150SJ14 - Distributed Systems (VertSys14)**
**Duration:**

1 Semester

**Turnus of offer:**

each winter semester

**Credit points:**

6

**Course of study, specific field and term:**

- Master Computer Science 2019 (compulsory), Canonical Specialization SSE, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (basic module), Applied computer science, 1st or 2nd semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester
- Master IT-Security 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Medical Informatics 2014 (basic module), ehealth / infomatics, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), Applied computer science, 1st or 2nd semester
- Master Computer Science 2014 (optional subject), specialization field software systems engineering, 2nd or 3rd semester
- Master Computer Science 2014 (basic module), Applied computer science, 1st or 2nd semester

**Classes and lectures:**

- Distributed Systems (lecture, 2 SWS)
- Distributed Systems (exercise, 2 SWS)

**Workload:**

- 60 Hours in-classroom work
- 60 Hours private studies
- 40 Hours e-learning
- 20 Hours exam preparation

**Contents of teaching:**

- Introduction and motivation
- Protocols and layered models
- Message representations
- Realization of network services
- Communication mechanisms
- Addresses, names and directory services
- Synchronisation
- Replication and consistency
- Fault tolerance
- Distributed transactions
- Security

**Qualification-goals/Competencies:**

- The participants will acquire a deep understanding for problems to be solved in distributed systems, such as synchronization, error handling, naming etc.
- They know the most important services in distributed systems such as name service, distributed file systems etc.
- They are able to program simple distributed applications and systems themselves.
- They know the most important algorithms in distributed systems, for instance for time synchronization, for leader election, or for mutual exclusion.
- They have a good feeling for when it makes sense to use distributed instead of centralized systems.
- They have a good feeling for what kind of solutions could best be used for what kind of problems in distributed Internet applications.

**Grading through:**

- written exam

**Responsible for this module:**

- [Prof. Dr. Stefan Fischer](#)

**Teacher:**

- [Institute of Telematics](#)
- [Prof. Dr. Stefan Fischer](#)
- [Dr. rer. nat. Florian-Lennert Lau](#)



**Literature:**

- A. Tanenbaum, M. van Steen: Distributed Systems: Principles and Paradigms - Prentice Hall 2006
- G. Coulouris, J. Dollimore, T. Kindberg, G. Blair: Distributed Systems - Concepts and Design - Addison Wesley 2012

**Language:**

- offered only in German

**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- None

Module Exam(s):

- CS4150-L1 Distributed Systems, written exam, 90min, 100% of module grade.

**CS4151-KP04, CS4151 - Architectures for Distributed Applications (SVA)**

**Duration:**

1 Semester

**Turnus of offer:**

each summer semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum parallel and distributed system architectures, 2nd or 3rd semester
- Master Computer Science 2012 (compulsory), specialization field software systems engineering, 2nd semester
- Master Computer Science 2012 (compulsory), advanced curriculum enterprise IT, 2nd semester

**Classes and lectures:**

- Architectures for Distributed Applications (lecture, 2 SWS)
- Architectures for Distributed Applications (exercise, 1 SWS)

**Workload:**

- 45 Hours in-classroom work
- 45 Hours private studies
- 30 Hours exam preparation

**Contents of teaching:**

- Motivation
- Software Architectures
- Basics: HTTP, XML & Co
- N-Tier Applications
- Service-Oriented and Event-Driven Architectures (SOA and EDA)
- Web-Oriented Architectures (Web 2.0)
- Overlay Networks
- Peer-to-Peer
- Grid and Cloud Computing
- Internet of Things

**Qualification-goals/Competencies:**

- The students are able to name the most important architectures for distributed systems, explain them, and compare them to each other.
- For each architecture, they know the most prominent and important implementation platforms and basically know how to use them.
- For a given problem, they can analyze which architecture is best suited to solve it, and they can design a plan for the solution's realization.

**Grading through:**

- Oral examination

**Responsible for this module:**

- [Prof. Dr.-Ing Horst Hellbrück](#)

**Teacher:**

- [Institute of Telematics](#)
- [Prof. Dr.-Ing Horst Hellbrück](#)

**Literature:**

- J. Dunkel, A. Eberhart, S. Fischer, C. Kleiner, A. Koschel: Systemarchitekturen für verteilte Anwendungen - Hanser-Verlag 2008
- I. Melzer et.al.: Service-Orientierte Architekturen mit Web Services - Spektrum-Verlag 2010

**Language:**

- offered only in German



**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercises as specified at the beginning of the semester.

Module Exam(s):

- CS4151-L1 System Architectures for Distributed Applications, oral exam, 100% of module grade.

**CS4160-KP06, CS4160SJ14 - Real-Time Systems (Echtzeit14)**
**Duration:**

1 Semester

**Turnus of offer:**

each summer semester

**Credit points:**

6

**Course of study, specific field and term:**

- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2019 (basic module), technical computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (optional subject), technical computer science, 1st or 2nd semester
- Master IT-Security 2019 (basic module), technical computer science, 1st or 2nd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, 1st semester
- Master Medical Informatics 2014 (basic module), computer science, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), specific, 1st or 2nd semester
- Master Computer Science 2014 (basic module), technical computer science, 1st or 2nd semester

**Classes and lectures:**

- Real-Time Systems (lecture, 2 SWS)
- Real-Time Systems (exercise, 2 SWS)

**Workload:**

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Real-time processing (definitions, requirements)
- Process automation systems
- Real-time programming
- Process connectivity and networking
- Modelling of discrete event systems (automata, state charts)
- Modelling of continuous systems (differential equations, Laplace transformation)
- Application of design tools (Matlab/Simulink, Stateflow)

**Qualification-goals/Competencies:**

- The students are able to describe the fundamental problems of real-time processing.
- They are able to explain real-time computer systems for process automation, in particular SPS.
- They are able to program real-time systems in the IEC languages.
- They are able to elucidate process interfaces and real-time bus system.
- They are able to model, analyze and implement event discrete systems, in particular process control systems.
- They are able to model, analyze and implement continuous systems, in particular feedback control systems.
- They are able to make use of design tools for real-time systems.

**Grading through:**

- written exam

**Responsible for this module:**

- [Prof. Dr.-Ing. Mladen Berekovic](#)

**Teacher:**

- [Institute of Computer Engineering](#)
- [Prof. Dr.-Ing. Mladen Berekovic](#)

**Literature:**

- R. C. Dorf, R. H. Bishop: Modern Control Systems - Prentice Hall 2010
- L. Litz: Grundlagen der Automatisierungstechnik - Oldenbourg 2012
- M. Seitz: Speicherprogrammierbare Steuerungen - Fachbuchverlag Leipzig 2012
- H. Wörn, U. Brinkschulte: Echtzeitsysteme - Berlin: Springer 2005
- S. Zacher, M. Reuter: Regelungstechnik für Ingenieure - Springer-Vieweg 2014



**Language:**

- offered only in English

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**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):

- CS4160-L1: Real-Time Systems, written exam, 90min, 100% of the module grade

**CS4210-KP06, CS4210 - Cryptographic Protocols (KrypProto)**
**Duration:**

1 Semester

**Turnus of offer:**

normally each year in the summer semester

**Credit points:**

6

**Course of study, specific field and term:**

- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master IT-Security 2019 (optional subject), IT Security and Privacy, 1st, 2nd, or 3rd semester
- Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester

**Classes and lectures:**

- Cryptographic Protocols (lecture, 3 SWS)
- Cryptographic Protocols (exercise, 1,5 SWS)

**Workload:**

- 85 Hours private studies and exercises
- 75 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Complex cryptographic protocols, security analyses
- Anonymity and Privacy, Private Computation and Information Retrieval, Differential Privacy
- Quantum Cryptographie
- Steganography, digital seals and watermarks
- secure e-commerce, electronic money, online elections

**Qualification-goals/Competencies:**

- The students can reason about cryptographic methods and their application in communication systems.
- The are able to select suitable security primitives for given applications and to implement them.
- The can conduct a security analysis of communication protocols.
- They can designate the weaknesses of real systems and evaluate them.

**Grading through:**

- Oral examination

**Requires:**

- Cryptology (CS3420-KP04, CS3420)

**Responsible for this module:**

- [Prof. Dr. Rüdiger Reischuk](#)

**Teacher:**

- [Institute for Theoretical Computer Science](#)
- [Prof. Dr. Maciej Liskiewicz](#)
- [Prof. Dr. Rüdiger Reischuk](#)

**Literature:**

- Lindell: Tutorials on the Foundations of Cryptography - Springer 2017
- J. Katz, Y. Lindell: Introduction to Modern Cryptography - CRC Press 2014
- Goldreich: Fundamentals of Cryptography - Cambridge Univ. Press 2004
- I. Cox, M. Miller, J. Bloom, J. Fridrich, T. Kalkerm: Digital Watermarking and Steganography - Morgan Kaufmann 2008
- Dwork, Roth: The Algorithmic Foundations of Differential Privacy - 2014

**Language:**

- English, except in case of only German-speaking participants

**Notes:**

Admission requirements for taking the module:  
- None (the competencies under

**CS4220-KP04, CS4220 - Pattern Recognition (Muster)**
**Duration:**

1 Semester

**Turnus of offer:**

not available anymore

**Credit points:**

4

**Course of study, specific field and term:**

- Master MES 2020 (optional subject), medical engineering science, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master MES 2014 (optional subject), medical engineering science, Arbitrary semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester
- Master CLS 2016 (compulsory), mathematics, 2nd semester
- Master Medical Informatics 2019 (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), medical image processing, 1st or 2nd semester

**Classes and lectures:**

- Pattern Recognition (lecture, 2 SWS)
- Pattern Recognition (exercise, 1 SWS)

**Workload:**

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Introduction to probability theory
- Principles of feature extraction and pattern recognition
- Bayes decision theory
- Discriminance functions
- Neyman-Pearson test
- Receiver Operating Characteristic
- Parametric and nonparametric density estimation
- kNN classifiers
- Linear classifiers
- Support vector machines and kernel trick
- Random Forest
- Neural Nets
- Feature reduction and feature transforms
- Validation of classifiers
- Selected application scenarios: acoustic scene classification for the selection of hearing-aid algorithms, acoustic event recognition, attention classification based on EEG data, speaker and emotion recognition

**Qualification-goals/Competencies:**

- Students are able to describe the main elements of feature extraction and pattern recognition.
- They are able to explain the basic elements of statistical modeling.
- They are able to use feature extraction, feature reduction and pattern classification techniques in practice.

**Grading through:**

- Written or oral exam as announced by the examiner

**Responsible for this module:**

- [Prof. Dr.-Ing. Alfred Mertins](#)

**Teacher:**

- [Institute for Signal Processing](#)
- [Prof. Dr.-Ing. Alfred Mertins](#)

**Literature:**

- R. O. Duda, P. E. Hart, D. G. Storck: Pattern Classification - New York: Wiley

**Language:**

- offered only in German

**Notes:**

Prerequisites for attending the module:

- None

Prerequisites for the exam:

- Successful completion of homework assignments during the semester (at least 50% of max. points) and successful project task.

Modul exam:

- CS4220-L1:Pattern Recognition, written exam, 90 Min, 100% of modul grade

**CS4250-KP04, CS4250 - Computer Vision (CompVision)**
**Duration:**

1 Semester

**Turnus of offer:**

each summer semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master CLS 2023 (optional subject), computer science, 2nd or 3rd semester
- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Computer Science 2019 (optional subject), Elective, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Biophysics 2019 (optional subject), Elective, 2nd semester
- Master Biomedical Engineering (optional subject), advanced curriculum, 2nd semester
- Master CLS 2016 (optional subject), computer science, 2nd or 3rd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2012 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Master CLS 2010 (compulsory), computational life science / imaging, 2nd semester
- Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester
- Master Computer Science 2012 (compulsory), specialization field robotics and automation, 2nd semester
- Master Computer Science 2012 (compulsory), specialization field bioinformatics, 2nd semester
- Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd semester

**Classes and lectures:**

- Computer Vision (lecture, 2 SWS)
- Computer Vision (exercise, 1 SWS)

**Workload:**

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Introduction to human and computer vision
- Sensors, cameras, optics and projections
- Image features: edges, intrinsic dimension, Hough transform, Fourier descriptors, snakes
- Range imaging and 3-D cameras
- Motion and optical flow
- Object recognition
- Example applications

**Qualification-goals/Competencies:**

- Students can understand the basics of computer vision.
- They can explain and perform camera choice and calibration.
- They can explain and apply the basic methods for feature extraction, motion estimation, and object recognition.
- They can indicate appropriate methods for different kinds of computer-vision applications.

**Grading through:**

- Oral examination

**Responsible for this module:**

- [Prof. Dr.-Ing. Erhardt Barth](#)

**Teacher:**

- [Institute for Neuro- and Bioinformatics](#)
- [Prof. Dr.-Ing. Erhardt Barth](#)

**Literature:**

- Richard Szeliski: Computer Vision: Algorithms and Applications - Springer, Boston, 2011
- David Forsyth and Jean Ponce: Computer Vision: A Modern Approach - Prentice Hall, 2003

**Language:**



- English, except in case of only German-speaking participants

**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Regular participation in the exercises as specified at the beginning of the semester
- Successful completion of exercise slips as specified at the beginning of the semester

Module exam(s):

- CS4250-L1: Computer Vision, oral exam, 100% of module grade

Is identical to module XM2330 of the University of Applied Sciences Lübeck

**CS4701-KP06 - Communication and System Security (KoSyS)**
**Duration:**

1 Semester

**Turnus of offer:**

each winter semester

**Credit points:**

6

**Course of study, specific field and term:**

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master IT-Security 2019 (compulsory), IT-Security, 1st or 2nd semester

**Classes and lectures:**

- Communication and System Security (lecture, 2 SWS)
- Communication and System Security (seminar-style lectures with exercises, 2 SWS)

**Workload:**

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Cryptographic procedures and protocols, security analyses
- IT security at system level, security mechanisms
- Security, privacy and trust of special systems such as Cloud and IoT
- Code analysis
- Security management, legal framework conditions
- Security problems in IT systems

**Qualification-goals/Competencies:**

- Students can explain the basic methods in the field of cybersecurity and apply them to case studies.
- They can demonstrate a deeper understanding of cryptographic methods and their applications in communication systems.
- They can analyze the entire spectrum of the security of a system.
- They can explain modelling techniques and describe experiences with their use.
- They can apply a variety of standard techniques to increase the security of a system.

**Grading through:**

- Viva Voce or test
- written homework

**Is requisite for:**

- Current Topics in IT Security (CS5195-KP04)

**Requires:**

- Cybersecurity (CS2250-KP04)
- Cryptology (CS3420-KP04, CS3420)

**Responsible for this module:**

- [Prof. Dr.-Ing. Thomas Eisenbarth](#)

**Teacher:**

- [Institute for IT Security](#)
- [Prof. Dr.-Ing. Thomas Eisenbarth](#)
- [Prof. Dr. Rüdiger Reischuk](#)
- [Prof. Dr. rer. nat. Esfandiar Mohammadi](#)

**Literature:**

- Stallings, Brown: Computer Security: Principles and Practice - 4th ed., Pearson, 2018
- Katz, Lindell: Introduction to Modern Cryptography - 2nd ed., CRC Press, 2014
- Stinson: Cryptography: Theory and Practice - 4th ed., CRC Press, 2018



**Language:**

- English, except in case of only German-speaking participants

**Notes:**

Admission requirements for taking the module:

- None (the skills listed under "Prerequisites" are required for this module, but are not a formal requirement)

Admission requirements for participating in module exam(s):

- Successful completion of exercise sheets as specified at the beginning of the semester
- 2 presentations during the semester

Module exam(s):

- CS4701-L1: Communication and System Security, oral exam, 100% of the module grade

The courses in this module are also part of CS4515-KP12.

<b>CS4702-KP06 - Computer Security (CoSec)</b>		
<b>Duration:</b>	<b>Turnus of offer:</b>	<b>Credit points:</b>
1 Semester	normally each year in the summer semester	6
<b>Course of study, specific field and term:</b>		
<ul style="list-style-type: none"> <li>• Master Robotics and Autonomous Systems 2019 (optional subject), Additionally recognized elective module, Arbitrary semester</li> <li>• Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester</li> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> <li>• Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester</li> <li>• Master IT-Security 2019 (optional subject), IT Security and Privacy, 1st, 2nd, or 3rd semester</li> </ul>		
<b>Classes and lectures:</b>		<b>Workload:</b>
<ul style="list-style-type: none"> <li>• Computer Security (lecture, 2 SWS)</li> <li>• Computer Security (practical course, 3 SWS)</li> </ul>		<ul style="list-style-type: none"> <li>• 85 Hours private studies</li> <li>• 75 Hours in-classroom work</li> <li>• 20 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b>		
<ul style="list-style-type: none"> <li>• Applied cryptography in systems and protocols: Overview of common methods and their applications</li> <li>• Efficient and secure implementation of common crypto procedures: multiple-precision arithmetic, efficient exponentiation, constant time algorithms etc.</li> <li>• Physical implementation attacks and countermeasures: Error injection attacks, passive physical attacks such as SPA/DPA and timing attacks, modern inference methods and associated cryptanalysis methods, classes of protective measures</li> <li>• Virtualization security and microarchitecture attacks: security concepts in the operating system and hypervisor, microarchitecture attacks such as cache attacks, spectre, etc., measures to restore system security</li> <li>• Trusted computing and hardware-assisted system security: How TPMs, Secure Elements and Trusted Execution work environments, basics and cryptographic techniques, design basics for secure systems</li> </ul>		
<b>Qualification-goals/Competencies:</b>		
<ul style="list-style-type: none"> <li>• The students can demonstrate a deep understanding of cryptographic methods and their applications in communication systems.</li> <li>• They can construct secure and efficient cryptographic primitives and implement them securely in computer systems.</li> <li>• They can explain methods and algorithms for efficient multiple-precision arithmetic.</li> <li>• They can perform basic side-channel attacks on systems with physical access or shared systems with code execution rights.</li> <li>• They can implement protection against specific physical attacks for cryptographic primitives.</li> <li>• They can evaluate the security of existing primitives.</li> </ul>		
<b>Grading through:</b>		
<ul style="list-style-type: none"> <li>• Viva Voce or test</li> <li>• written homework</li> </ul>		
<b>Requires:</b>		
<ul style="list-style-type: none"> <li>• Cybersecurity (CS2250-KP04)</li> </ul>		
<b>Responsible for this module:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr.-Ing. Thomas Eisenbarth</a></li> </ul>		
<b>Teacher:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Institute for IT Security</a></li> <li>• <a href="#">Prof. Dr.-Ing. Thomas Eisenbarth</a></li> </ul>		
<b>Literature:</b>		
<ul style="list-style-type: none"> <li>• S. Mangard, E. Oswald &amp; T. Popp: Power analysis attacks: Revealing the secrets of smart cards - Vol. 31, Springer Science &amp; Business Media, 2008</li> <li>• D. Stinson: Cryptography: Theory and Practice - 4th ed., CRC Press, 2018</li> <li>• : Recent literature</li> </ul>		
<b>Language:</b>		
<ul style="list-style-type: none"> <li>• English, except in case of only German-speaking participants</li> </ul>		



**Notes:**

Admission requirements for taking the module:

- None (the competencies under

**CS5070-KP04 - Advanced Topics Data Science and AI (Dataakuell)**

**Duration:**

1 Semester

**Turnus of offer:**

every summer semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, 3rd semester
- Master Computer Science 2019 (compulsory), Canonical Specialization Data Science and AI, Arbitrary semester
- Master Computer Science 2019 (optional subject), Elective, Arbitrary semester

**Classes and lectures:**

- CS5070-V: Advanced Topics Data Science and AI (lecture, 2 SWS)
- CS5070-S: Advanced Topics Data Science and AI (seminar, 1 SWS)

**Workload:**

- 60 Hours private studies
- 45 Hours in-classroom work
- 15 Hours exam preparation

**Contents of teaching:**

- Current research results and applications of data science and artificial intelligence techniques
- Probabilistic Differential Programming
- Automated Planning and Acting
- Quantum Computing
- Stochastic Relational Modeling and Learning

**Qualification-goals/Competencies:**

- All current techniques taught in the module can be named and defined by the students and their functional proofs can be explained on the basis of applications.
- Students are able to identify advantages and disadvantages of Data Science- and AI-based system development approaches.
- Students are able to identify ethical aspects and assess their implications.

**Grading through:**

- Oral examination

**Responsible for this module:**

- [Prof. Dr.-Ing. Nele Rußwinkel](#)

**Teacher:**

- [Institute of Information Systems](#)
- [Prof. Dr.-Ing. Nele Rußwinkel](#)
- [Prof. Dr. Sven Groppe](#)

**Literature:**

- : Current conference papers for the topics of the course will be announced in lectures

**Language:**

- German and English skills required

**Notes:**

Choose 1 out of 2: Students must attend one of the two courses.

Prerequisites for attending the module:

- None

Prerequisites for the exam:

- None

CS5130-KP04, CS5130 - Foundations of Ontologies and Databases for Information Systems (OntoDB)		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> <li>• Master CLS 2010 (optional subject), computer science, Arbitrary semester</li> <li>• Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester</li> <li>• Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Foundations of Ontologies and Databases in Information Systems (lecture, 2 SWS)</li> <li>• Foundations of Ontologies and Databases in Information Systems (exercise, 1 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 60 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 15 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Fundamentals of databases, conceptual modeling languages (ontologies), query languages, processes, and agents</li> <li>• Ontology based data access (OBDA)</li> <li>• Ontology evolution and ontology integration</li> <li>• Data exchange and data integration (schema mappings, duplicate detection, inconsistency handling, integration with relational and ontological constraints as well as with incomplete data)</li> <li>• Data stream processing (e.g., for sensor networks, robotics, web agents) with OBDA and complex event processing (CEP)</li> <li>• Non-symbolic data and their symbolic annotations (e.g., for applications in bioinformatics/computational biology and for media interpretation), syntax, semantics, hybrid decision and computation problems and their complexity, (analysis of) algorithms</li> <li>• Data- and ontology-oriented process analysis (e.g., for biological pathways) and process design (e.g., for non-trivial business processes)</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Knowledge: The module aims at introducing the students to the formal basics of databases and ontologies, so that they get an overview of concepts, methods, and theories for understanding, analyzing, and designing information systems in open large contexts, such as the web.</li> <li>• Skills: The students get a basic understanding of logical and formal methods, which allows them to assess the possibilities and limitations of information systems, be it concrete ones or those that still have to be designed. Assessment parameters are correctness and completeness (Does the system produce what is expected? If so, does it produce all results?) as well as expressiveness (Is it possible to formulate all required queries? What are equivalent query languages?) and, last but not least, performance (How long does it take the system to come up with an answer? How much space does it need?). In addition to these analysis skills, students receive logical modeling skills using real application scenarios from industry (business processing, integration of data resources, processing of time-based and event data), and medicine (sensor networks, genomic ontologies, annotation). Based on these, the student not only acquires the ability to assess which logical model is suitable for which application scenario, but also the ability to construct their own logical models where necessary.</li> <li>• Social Competence und Independent Work: Students work in groups to solve small exercises and project problems and sketch their solutions in short presentations. Independent work is promoted by exercises with practical ontology and database systems.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• written exam</li> </ul>		
<b>Is requisite for:</b> <ul style="list-style-type: none"> <li>• Web-Mining Agents (CS5131-KP08, CS5131)</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• Prof. Dr. rer. nat. habil. Ralf Möller</li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• Institute of Information Systems</li> <li>• Prof. Dr. rer. nat. habil. Ralf Möller</li> <li>• PD Dr. Özgür Özçep</li> </ul>		

**Literature:**

- S. Abiteboul, R. Hull, V. Vianu: Foundations of Databases - Addison-Wesley, 1995
- M. Arenas, P. Barcelo, L. Libkin, and F. Murlak: Foundations of Data Exchange - Cambridge University Press, 2014
- F. Baader, D. Calvanese, D.L. McGuinness, D. Nardi, and P.F. Patel-Schneider (Eds.): The Description Logic Handbook: Theory, Implementation, and Applications - Cambridge University Press, 2010
- S. Chakravarthy, Q. Jiang: Stream Data Processing A Quality of Service Perspective - Springer, 2009
- L. Libkin: Elements Of Finite Model Theory (Texts in Theoretical Computer Science. An Eatcs Series) - SpringerVerlag, 2004

**Language:**

- offered only in English

**Notes:**

Prerequisites for this module are:

- Algorithm and Data Structures (CS1001)
- Linear Algebra and Discrete Structures I+II (MA1000, MA1500)
- Databases (CS2700)

Recommended additional modules:

- Logic (CS1002)
- Bachelor Project Computer Science (CS3701), topic: logic programming
- Nonstandard Database Systems (CS3202)

**CS5131-KP08, CS5131 - Web-Mining Agents (WebMining)**

<b>Duration:</b>	<b>Turnus of offer:</b>	<b>Credit points:</b>
1 Semester	not available anymore	8

**Course of study, specific field and term:**

- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master CLS 2010 (optional subject), computer science, Arbitrary semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester

**Classes and lectures:**

- Web-Mining Agents (lecture, 4 SWS)
- Web-Mining Agents (exercise, 1 SWS)
- Web-Mining Agents (practical course, 1 SWS)

**Workload:**

- 120 Hours private studies
- 90 Hours in-classroom work
- 30 Hours exam preparation

**Contents of teaching:**

- Probabilities and generative models for discrete data
- Gaussian models, Bayesian and frequentist statistics, regression,
- Probabilistic graphical models (e.g., Bayesian networks), learning parameters and structures of probabilistic graphical models (BME, MAP, ML, EM algorithm), probabilistic classification, probabilistic relational models
- Probabilistic reasoning over time (dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, hidden Markov models, Kalman filters, exact inferences and approximations, learning dynamic Bayesian networks)
- Structural Causal Networks (Intervention, instrumental Variables, counterfactuals)
- Mixture models, latent linear models (LDA, LSI, PCA), sparse linear models,
- Decision making under uncertainty (utility theory, decision networks, value of information, sequential decision problems, value iteration, policy iteration, MDPs, decision-theoretic agents, POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks)
- Game theory, decisions with multiple agents (Nash equilibrium, Bayes-Nash equilibrium), social choice (voting, preferences, paradoxes, Arrow's Theorem, mechanism design (controlled autonomy)), rules of encounter
- Multimedia interpretation for web (re-)search (probabilistic ranking of interpretations, link analysis (e.g., citations), social network analysis)
- Building and exchanging symbolic annotations for web data (from named entity recognition to discourse representations)
- Information association, retrieval, query answering and recommendation

**Qualification-goals/Competencies:**

- **Knowledge:** Students can explain the agent abstraction, define web mining of rational behavior, and give details about the design of mining agents (goals, utilities, environments). They can describe the main features of environments. The notion of adversarial agent cooperation can be discussed in terms of decision problems and algorithms for solving these problems. For dealing with uncertainty in real-world scenarios, students can summarize how Bayesian networks can be employed as a knowledge representation and reasoning formalism in static and dynamic settings. In addition, students can define decision making procedures in simple and sequential settings, with and with complete access to the state of the environment. In this context, students can describe techniques for solving (partially observable) Markov decision problems, and they can recall techniques for measuring the value of information. Students can identify techniques for simultaneous localization and mapping, and can explain planning techniques for achieving desired states. Students can explain coordination problems and decision making in a multi-agent setting in term of different types of equilibria, social choice functions, voting protocol, and mechanism design techniques. Students can explain the difference between instance-based and model-based learning approaches, and they can enumerate basic machine learning technique for each of the two basic approaches, either on the basis of static data, or on the basis of incrementally incoming data. For dealing with uncertainty, students can describe suitable representation formalisms, and they explain how axioms, features, parameters, or structures used in these formalisms can be learned automatically with different algorithms. Students are also able to sketch different clustering techniques. They depict how the performance of learned classifiers can be improved by ensemble learning, and they can summarize how this influences computational learning theory. Algorithms for reinforcement learning can also be explained by students.
- **Skills:** Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply Bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibria states, e.g., Nash

equilibria. For multi-agent decision making students will apply different voting protocols and compare and explain the results. Students derive decision trees and, in turn, propositional rule sets from static data as well as temporal or streaming data. Students present and apply the basic idea of first-order inductive learning. They apply the BME, MAP, ML, and EM algorithms for learning parameters of Bayesian networks and compare the different algorithms. They also know how to carry out Gaussian mixture learning. Students can describe basic clustering techniques and explain the basic components of those techniques. Students compare related machine learning techniques, e.g., k-means clustering and nearest neighbor classification. They can distinguish various ensemble learning techniques and compare the different goals of those techniques.

- Social competence: Students work in groups in order to solve small exercise and project assignments and present them in short talks in the plenum. In the associated project lab the students develop a larger project using up-to-date programming languages and software tools for data science applications.

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**Grading through:**

- Written or oral exam as announced by the examiner

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**Responsible for this module:**

- [Prof. Dr. rer. nat. habil. Ralf Möller](#)

**Teacher:**

- [Institute of Information Systems](#)
- [Prof. Dr. rer. nat. habil. Ralf Möller](#)
- [PD Dr. Özgür Özçep](#)

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**Literature:**

- M. Hall, I. Witten and E. Frank: Data Mining: Practical Machine Learning Tools and Techniques - Morgan Kaufmann, 2011
- D. Koller, N. Friedman: Probabilistic Graphical Models: Principles and Techniques - MIT Press, 2009
- K. Murphy: Machine Learning: A Probabilistic Perspective - MIT Press, 2012
- S. Russel, P. Norvig: Artificial Intelligence: A Modern Approach - Pearson Education, 2010
- Y. Shoham, K. Leyton-Brown: Multiagent-Systems: Algorithmic, Game-Theoretic, and Logical Foundations - Cambridge University Press, 2009

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**Language:**

- offered only in English

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**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercises as specified at the beginning of the semester.

Module Exam(s):

- CS5131-L1: Web Mining Agents, oral exam, 100% of module grade.

Competencies from the following modules are required for this module (not a hard entry requirement):

- Algorithms and Data Structures (CS1001).
- Linear Algebra and Discrete Structures I + II (MA1000, MA1500)
- Databases (CS2700)
- Stochastics 1 (MA2510) or Fundamentals of Statistics (PY1800)
- Introduction to Logic (CS1002)
- Artificial Intelligence 1 (CS3204)
- Information Systems (CS4130)

<b>CS5140-KP04, CS5140 - Semantic Web (SemWeb)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> <li>• Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester</li> <li>• Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester</li> <li>• Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester</li> <li>• Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 2nd or 3rd semester</li> <li>• Master Computer Science 2012 (optional subject), specialization field software systems engineering, 2nd or 3rd semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Semantic Web (lecture, 2 SWS)</li> <li>• Semantic Web (exercise, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 65 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 10 Hours exam preparation</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Introduction with overview of the W3C Semantic Web family of languages</li> <li>• Data management for Semantic Web data, in particular indexing approaches</li> <li>• Query processing for Semantic Web queries (central, parallel, and distributed, in particular in the cloud)</li> <li>• Processing strategies for Semantic Web rules and ontologies</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students can judge about the possibilities and limits of the Semantic Web.</li> <li>• They can evaluate the consequences of the Semantic Web approach for data modelling, administration and processing, and finally for applications.</li> <li>• They can develop Semantic Web applications.</li> <li>• They can explain and apply specialized approaches for Semantic Web databases.</li> <li>• They can discuss about open research questions in the area of the Semantic Web.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Oral examination</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. Sven Groppe</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute of Information Systems</a></li> <li>• <a href="#">Prof. Dr. Sven Groppe</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• P. Hitzler, M. Krötzsch, S. Rudolph: Foundations of Semantic Web Technologies - Chapman &amp; Hall / CRC, 2009</li> <li>• T. Segaran, J. Taylor, C. Evans: Programming the Semantic Web - O'Reilly, 2009</li> <li>• F. Bry, J. Maluszynski: Semantic Techniques for the Web - Springer, 2009</li> <li>• J. T. Pollock: Semantic Web for Dummies - Wiley, 2009</li> <li>• J. Hebler, M. Fisher, R. Blace, A. Perez-Lopez, M. Dean: Semantic Web Programming - Wiley, 2009</li> <li>• G. Antoniou, F. van Harmelen: A Semantic Web Primer - MIT Press, 2008</li> <li>• V. Kashyap, C. Bussler, M. Moran: The Semantic Web - Springer, 2008</li> <li>• S. Groppe: Data Management and Query Processing in Semantic Web Databases - Springer, 2011</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b>		



Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Active participation in lecture and tutorial

Module Exam(s):

- CS5140-L1: Semantic Web, oral exam, 100% of module grade.

<b>CS5153-KP04, CS5153 - Wireless Sensor Networks (DISensorN)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> <li>• Master Medical Informatics 2014 (optional subject), computer science, 1st or 2nd semester</li> <li>• Master Computer Science 2012 (optional subject), specialization field IT security and safety, 3rd semester</li> <li>• Master Computer Science 2012 (optional subject), advanced curriculum parallel and distributed system architectures, 2nd or 3rd semester</li> <li>• Master Computer Science 2012 (optional subject), advanced curriculum organic computing, 2nd or 3rd semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Wireless Sensor Networks (lecture, 2 SWS)</li> <li>• Wireless Sensor Networks (exercise, 1 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 60 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 15 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Basics of Sensor Networks</li> <li>• Architecture of Sensor Nodes and of Sensor Networks</li> <li>• Identities and addressing</li> <li>• Wireless communication</li> <li>• Data management and topology control</li> <li>• Time Synchronization</li> <li>• Localization</li> <li>• Energy harvesting</li> <li>• Applications</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• The students are able to present the potential, benefits and limitations of sensor networks.</li> <li>• They are able to cope with analysis, design, and evaluation of protocols in sensor networks.</li> <li>• They are able to interpret and pursue current research activities for sensor networks.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Oral examination</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr.-Ing. Mladen Berekovic</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute of Computer Engineering</a></li> <li>• Dr. rer. nat. Javad Ghofrani</li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• H. Karl, A. Willig: Protocols and Architectures of Wireless Sensor Networks - Wiley, 2005</li> <li>• F. Zhao, L. Guibas: Wireless Sensor Networks - Morgan Kaufmann, 2004</li> <li>• B.-C. Renner: Sustained Operation of Sensor Nodes with Energy Harvesters and Supercapacitors - Books on Demand 2013</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in English</li> </ul>		
<b>Notes:</b>		



Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):

- CS5153-L1: Wireless Sensor Networks, oral exam, 100% of the module grade

**CS5158-KP04, CS5158 - Advanced Internet Technologies (AdInternet)**
**Duration:**

1 Semester

**Turnus of offer:**

every summer semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2012 (optional subject), advanced curriculum enterprise IT, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), specialization field software systems engineering, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 2nd or 3rd semester

**Classes and lectures:**

- Advanced Internet Technologies (lecture, 2 SWS)
- Advanced Internet Technologies (exercise, 1 SWS)

**Workload:**

- 60 Hours private studies
- 45 Hours in-classroom work
- 15 Hours exam preparation

**Contents of teaching:**

1. Fundamentals: Internet architecture, Border Gateway Protocol (BGP), Multi-Protocol Label Switching (MPLS)
2. Software-Defined Networking (SDN): Rationale, OpenFlow, P4
3. Transport Layer: QUIC, HTTP3, MQTT, IoT
4. Specialized network architectures: named data networking (NDN), LoRaWAN, delay-tolerant networking (DTN)
5. Future topics: security, future of the Internet

**Qualification-goals/Competencies:**

- Students understand the fundamental design decisions that led to the development of Internet protocols.
- They are familiar with basic, generally applicable criteria for network design (end-to-end argument, fate sharing, etc.).
- They can explain and apply current routing methods such as BGP, MPLS, and SDN in detail.
- They can explain the differences between modern transport protocols such as QUIC, HTTP, and MQTT and their predecessors, describe the protocols, and use them in their application contexts.
- They are familiar with the basic principles of current specialized network technologies such as NDN, LoRaWAN, and DTN and know when and how to use them.
- They have a clear idea of the development paths the Internet may follow in the future.

**Grading through:**

- Oral examination

**Responsible for this module:**

- [Prof. Dr. Stefan Fischer](#)

**Teacher:**

- [Institute of Telematics](#)
- [Dr. rer. nat. Florian-Lennert Lau](#)

**Literature:**

- Kurose, J. F., & Ross, K. W.: *Computer Networking: A Top-Down Approach - 9. Ed.*, Pearson., 2025
- Chataut, R., Sharma, H., & Akl, R.: *A Comprehensive Review of IoT Applications and Future Prospects*. Sensors - MDPI, 2023
- Akamai Technologies: *HTTP/3 and QUIC: Past, Present, and Future - 2021*
- Saxena, D.: *Named Data Networking: A Survey*. Computer Science Review - Elsevier, 2016
- Castillo, V., Gómez, Á., Salcedo, J., & López, L.: *Delay and Disruption Tolerant Networking for Terrestrial and TCP/IP Applications: A Systematic Literature Review - Journal of Cybersecurity and Privacy, 4(3), 493 - 520*. MDPI, 2024

**Language:**

- German and English skills required

**Notes:**



Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- None

Module Examination(s):

- CS5158-L1: Advanced Internet Technologies, oral examination, 100% of module mark.

(Was also part of CS4518-KP12)

<b>CS5161-KP04 - Nano communication networks (NanoNet)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester</li> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Nano communication networks (lecture, 2 SWS)</li> <li>• Nano communication networks (project work, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 45 Hours in-classroom work</li> <li>• 45 Hours private studies</li> <li>• 15 Hours exam preparation</li> <li>• 15 Hours work on project</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Networks und protocols</li> <li>• Self-assembly systems</li> <li>• Reductions and compilation</li> <li>• Definitions &amp; associations of nanonetworks</li> <li>• Simulation tools for nanonetworks</li> <li>• Deployment in medical application scenarios</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students know and understand the basic concepts of nanonetworks.</li> <li>• Students know how to use advanced modeling techniques.</li> <li>• Students know th basic concepts of nanoscale computational models.</li> <li>• Students know the concepts of reductions and can apply it to nanoscale algorithms.</li> <li>• Students know and understand self-assembly systems and crystal formation.</li> <li>• Students know and understand the constraints and peculiarities at the nanoscale.</li> <li>• Students possess in-depth understanding of network structures and topologies of nanonetworks</li> <li>• Students know how to verify or falsify a model using simulation tools.</li> <li>• Interdisciplinary aspects:</li> <li>• Students have elementary modeling skills.</li> <li>• Students can transfer basic theoretical concepts to related questions.</li> <li>• Students can understand and implement various algorithms and transfer the knowledge they have acquired to other subjects.</li> <li>• Students can work on simple tasks in a team.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Oral examination</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. Stefan Fischer</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute of Telematics</a></li> <li>• <a href="#">Dr. rer. nat. Florian-Lennert Lau</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• <a href="#">Florian-Lennert A. Lau: Nanonetworks - The Future of Communication And Computation</a></li> <li>• <a href="#">Baris Atakan: Molecular Communications and Nanonetworks From Nature To Practical Systems</a></li> <li>• <a href="#">Robert A. Freitas: Nanomedicine: Biocompatibility</a></li> <li>• <a href="#">Peter Clote &amp; Evangelos Kranakis: Boolean Functions and Computation Models</a></li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• English, except in case of only German-speaking participants</li> </ul>		
<b>Notes:</b>		



Prerequisites for attending the module:

- None

Prerequisites for the exam:

- Successful completion of homework assignments during the semester.

<b>CS5162-KP04 - Mobile communication systems (MobiCom)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> <li>• Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Mobile communication systems (lecture, 2 SWS)</li> <li>• Mobile communication systems (exercise, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 60 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 15 Hours exam preparation</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Motivation and Overview (Introduction to mobile communication systems and their applications)</li> <li>• Wireless Transmission (Frequencies, transmission properties, multipath transmission, mobility)</li> <li>• Wireless Security Layer (Medium Access Control, scheduling, error control)</li> <li>• Wireless Technologies (Wireless Local Area Networks, Wireless Personal Area Networks, Telecommunications, Broadcasting and Satellite Systems, Low Power Wide Area Networks)</li> <li>• Location and Tracking (Applications, real-time automation in production, and logistics)</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students can highlight the particularities of wireless mobile communication systems and the challenges and concepts.</li> <li>• They interpret and follow current research activities and technology trends.</li> <li>• They can systematically design and evaluate protocols for mobile communication systems and their applications.</li> <li>• They can design, implement, and operate real-time applications based on wireless communication networks.</li> <li>• They can analyze technical requirements for mobile radio systems and components and choose solutions.</li> <li>• They can carry out diagnoses, tests and optimizations of wireless networked mobile communication systems.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Oral examination</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr.-Ing Horst Hellbrück</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute of Telematics</a></li> <li>• <a href="#">Prof. Dr.-Ing Horst Hellbrück</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• Jochen Schiller: Mobile Communications - 2nd Edition, Addison-Wesley, 2004, Signature: VK 2650 2005 A 302</li> <li>• Andrew S. Tanenbaum: Computer Networks - 4th Edition, Prentice-Hall, 2003, Signature: VK 1670 2004 A 823</li> <li>• Charles E. Perkins: Ad Hoc Networking - 1st Edition, Addison Wesley Professional, December 2000, Signature: VK 1670 2002 A 640</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• German and English skills required</li> </ul>		
<b>Notes:</b> <p>Prerequisites for attending the module: - None</p> <p>Prerequisites for the exam: - Successful completion of homework assignments during the semester.</p>		

<b>CS5163-KP04 - Internet of Things (IoT)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester</li> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Internet of Things (lecture, 2 SWS)</li> <li>• Internet of Things (exercise, 1 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 60 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 15 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Introduction and basics of the Internet of Things (IoT)</li> <li>• Components of the IoT: sensors, actuators, gateways and networks</li> <li>• IoT architectures: cloud-centric, edge computing and fog computing</li> <li>• Communication protocols in IoT: MQTT, CoAP, HTTP</li> <li>• Network technologies for IoT: LoRaWAN, ZigBee, Bluetooth, 6LoWPAN</li> <li>• Security and data protection concepts in IoT</li> <li>• IoT data management: data collection, storage and analysis</li> <li>• Use of Edge AI and Machine Learning in IoT</li> <li>• IoT use cases: Smart Cities, Industry 4.0, Healthcare, Logistics</li> <li>• Challenges and Future Trends in IoT</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students can explain basic concepts and architectures of the Internet of Things.</li> <li>• They can analyze the requirements and challenges in the development of IoT systems.</li> <li>• They can explain and evaluate the most important communication protocols and network solutions for IoT applications.</li> <li>• They can explain technological as well as societal developments that have led to massive changes in the Internet's infrastructure (growth, innovations, mobile communications, )</li> <li>• They can explain the importance of data protection and security in the IoT and can implement appropriate measures.</li> <li>• They can design, implement and test basic IoT applications.</li> <li>• They can efficiently collect, analyze and interpret data from IoT systems.</li> <li>• They can recognize the potential of Edge AI and machine learning for optimizing IoT systems.</li> <li>• They can deal with real-world use cases and be able to develop solutions for specific industries.</li> <li>• They recognize the current trends and future developments in the IoT area and can evaluate them critically.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Written or oral exam as announced by the examiner</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. Stefan Fischer</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute of Telematics</a></li> <li>• <a href="#">Dr. Mohamed Hail</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• Olivier Hersent, David Boswarthick, Omar Elloumi: The Internet of Things: Key Applications and Protocols - Wiley, 2012</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• German and English skills required</li> </ul>		
<b>Notes:</b>		



Replaces CS5158 Advanced Internet Technologies.

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- None

Module Examination(s):

- CS5163-L1: Internet of Things, oral examination, 100% of module mark.

(Is also part of CS4518-KP12)

replaces CS5158 Advanced Internet Technologies

<b>CS5164-KP04 - Distributed AI (DistAI)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b>		
<ul style="list-style-type: none"> <li>• Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester</li> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b>		<b>Workload:</b>
<ul style="list-style-type: none"> <li>• Distributed AI (lecture, 1 SWS)</li> <li>• Distributed AI (practical course, 2 SWS)</li> </ul>		<ul style="list-style-type: none"> <li>• 45 Hours work on project</li> <li>• 45 Hours in-classroom work</li> <li>• 15 Hours private studies</li> <li>• 15 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b>		
<ul style="list-style-type: none"> <li>• Introduction and Basics: Neural network basics - Transformer models</li> <li>• Edge AI: Concepts and model architecture, e.g. MobileNet - practical and technical requirements - Application examples - Process for reducing parameters, e.g. pruning</li> <li>• Federated Learning: Concepts and applications - Voting and refinement procedures</li> <li>• Large Models in the Cloud: Concepts of large Data Warhouses and -Centers - Practical and technical basics, e.g. Docker and Kubernetes - Implementation through distribution and combination, e.g. data parallelism, ensembling and mixture of experts</li> <li>• Agentic AI: Concepts and architectures - Model Context Protocol (MCP) - Agent-to-Agent communication - Frameworks and use cases</li> </ul>		
<b>Qualification-goals/Competencies:</b>		
<ul style="list-style-type: none"> <li>• Students are able to explain traditional machine learning algorithms, convolutional neural networks, transformers and generative transformers.</li> <li>• Students can motivate and explain EdgeAI applications and can explain and implement the procedures for reducing the parameters in CNNs.</li> <li>• Students are familiar with applications in which federated learning is necessary or desirable.</li> <li>• Students are able to name and explain various federated learning methods, explain the advantages and disadvantages and implement them in basic terms.</li> <li>• Students can explain the basic capabilities of large data centers in the implementation of large AI models and address the challenges in resource consumption.</li> <li>• Students will be able to describe the differences between traditional multi-agent systems and agentic AI.</li> <li>• They can explain the Model Context Protocol (MCP), the Agent Communication Protocol (ACP) and the Agent-2-Agent Protocol (A2A) in basic terms and correctly select and implement their use in the context of applications.</li> <li>• They know at least three current frameworks for the realization of agentic AI applications and can implement them in at least one framework.</li> <li>• They know the risks of Agentic AI and the current protocols and frameworks and can assess these against the benefits of such a platform.</li> </ul>		
<b>Grading through:</b>		
<ul style="list-style-type: none"> <li>• Written or oral exam as announced by the examiner</li> </ul>		
<b>Responsible for this module:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. Stefan Fischer</a></li> </ul>		
<b>Teacher:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Institute of Telematics</a></li> <li>• <a href="#">Prof. Dr. Stefan Fischer</a></li> </ul>		
<b>Literature:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Raghubir Singh, Sukhpal Singh Gill: Edge AI: A survey</a></li> <li>• <a href="#">MD Abdullah Al Nasim et al.: Principles and Components of Federated Learning</a></li> <li>• <a href="#">Paula Raissa Silva, João Vinagre, João Gama: Towards federated learning: An overview of methods and applications</a></li> <li>• <a href="#">Zhengxian Lu, Fangyu Wang, Zhiwei Xu, Fei Yang, Tao Li: On the Performance and Memory Footprint of Distributed Training: An Empirical Study on Transformers</a></li> </ul>		



- [Abul Ehtesham, Aditi Singh, Gaurav Kumar Gupta, Saket Kumar: A survey of agent interoperability protocols: Model Context Protocol \(MCP\), Agent Communication Protocol \(ACP\), Agent-to-Agent Protocol \(A2A\), and Agent Network Protocol \(ANP\) - arXiv:2505.02279v2 \[cs.AI\], 2025](#)
- [Ken Huang: Agentic AI - Theories and Practices - Springer, 2025](#)

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**Language:**

- German and English skills required

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**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- None

Module Examination(s):

- CS5164-L1: Distributed AI, oral examination, 100% of module mark.

(Is also part of CS4517-KP12)

**CS5170-KP04, CS5170 - Hardware/Software Co-Design (HWSWCod)**
**Duration:**

1 Semester

**Turnus of offer:**

each winter semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master Computer Science 2019 (compulsory), Canonical Specialization SSE, Arbitrary semester
- Master Computer Science 2019 (optional subject), Elective, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester
- Master Computer Science 2014 (compulsory), specialization field software systems engineering, 1st or 2nd semester
- Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 1st or 3rd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2012 (optional subject), specialization field robotics and automation, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum parallel and distributed system architectures, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester
- Master Computer Science 2012 (compulsory), specialization field software systems engineering, 2nd semester

**Classes and lectures:**

- Hardware/Software Co-Design (lecture, 2 SWS)
- Hardware/Software Co-Design (exercise, 1 SWS)

**Workload:**

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- System design flow
- Basic architectures for HW/SW systems
- System design and modelling
- System synthesis
- Algorithms for scheduling
- System partitioning
- Algorithms for system partitioning
- Design systems
- Performance analysis
- System design and specification with SystemC
- Application examples

**Qualification-goals/Competencies:**

- Students are able to determine a suitable hardware/software architecture for a given system description
- They are able to determine and describe the pros and cons of implementation alternatives
- They are able to apply methods for system partitioning
- They are able to translate non-formal system descriptions into formal models
- They are able to explain the different steps in system synthesis
- They are able to estimate the quality of system designs
- They are able to create system descriptions in SystemC

**Grading through:**

- Written or oral exam as announced by the examiner

**Responsible for this module:**

- [Prof. Dr.-Ing. Mladen Berekovic](#)

**Teacher:**

- [Institute of Computer Engineering](#)
- [Prof. Dr.-Ing. Mladen Berekovic](#)

**Literature:**

- F. Kesel: Modellierung von digitalen Systemen mit SystemC - Oldenbourg Verlag 2012
- Teich, J., Haubelt, C.: Digital Hardware/Software-Systeme. Synthese und Optimierung - Berlin: Springer 2007



**Language:**

- offered only in German

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**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):

- CS5170-L1: Hardware/Software Co-Design, oral exam, 100% of the module grade

<b>CS5260-KP04, CS5260SJ14 - Speech and Audio Signal Processing (SprachAu14)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> every second semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b>		
<ul style="list-style-type: none"> <li>• Master CLS 2023 (optional subject), Elective, Arbitrary semester</li> <li>• Master Robotics and Autonomous Systems 2019 (optional subject), Elective, Arbitrary semester</li> <li>• Master MES 2020 (optional subject), medical engineering science, Arbitrary semester</li> <li>• Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester</li> <li>• Master Medical Informatics 2019 (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester</li> <li>• Master MES 2014 (optional subject), medical engineering science, Arbitrary semester</li> <li>• Master CLS 2010 (optional subject), computer science, Arbitrary semester</li> <li>• Master Medical Informatics 2014 (optional subject), computer science, 1st or 2nd semester</li> <li>• Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b>		<b>Workload:</b>
<ul style="list-style-type: none"> <li>• Speech and Audio Signal Processing (lecture, 2 SWS)</li> <li>• Speech and Audio Signal Processing (exercise, 1 SWS)</li> </ul>		<ul style="list-style-type: none"> <li>• 55 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 20 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b>		
<ul style="list-style-type: none"> <li>• Speech production and human hearing</li> <li>• Physical models of the auditory System</li> <li>• Dynamic compression</li> <li>• Spectral analysis: Spectrum and cepstrum</li> <li>• Spectral perception and masking</li> <li>• Vocal tract models</li> <li>• Linear prediction</li> <li>• Coding in time and frequency domains</li> <li>• Speech synthesis</li> <li>• Noise reduction and echo compensation</li> <li>• Source localization and spatial reproduction</li> <li>• Basics of automatic speech recognition</li> </ul>		
<b>Qualification-goals/Competencies:</b>		
<ul style="list-style-type: none"> <li>• Students are able to describe the basics of human speech production and the corresponding mathematical models.</li> <li>• They are able to describe the process of human auditory perception and the corresponding signal processing tools for mimicing auditory perception.</li> <li>• They are able to present basic knowledge of statistical speech modeling and automatic speech recognition.</li> <li>• They can describe and use signal processing methods for source separation and room-acoustic measurements.</li> </ul>		
<b>Grading through:</b>		
<ul style="list-style-type: none"> <li>• Written or oral exam as announced by the examiner</li> </ul>		
<b>Responsible for this module:</b>		
<ul style="list-style-type: none"> <li>• Prof. Dr.-Ing. Markus Kallinger</li> </ul>		
<b>Teacher:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Institute for Signal Processing</a></li> <li>• Prof. Dr.-Ing. Markus Kallinger</li> </ul>		
<b>Literature:</b>		
<ul style="list-style-type: none"> <li>• L. Rabiner, B.-H. Juang: Fundamentals of Speech Recognition - Upper Saddle River: Prentice Hall 1993</li> <li>• J. O. Heller, J. L. Hansen, J. G. Proakis: Discrete-Time Processing of Speech Signals - IEEE Press</li> </ul>		
<b>Language:</b>		
<ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		



**Notes:**

Prerequisites for attending the module:

- None

Prerequisites for the exam:

- Successful completion of assignments during the semester.

Modul exam:

- CS5260-L1: Speech and Audio Signal Processing, written or oral exam, 100% of modul grade

Mentioned in SGO MML under CS5260 (without SJ14).

**CS5450-KP04, CS5450 - Machine Learning (MaschLern)**
**Duration:**

1 Semester

**Turnus of offer:**

each winter semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master CLS 2023 (optional subject), computer science, 3rd semester
- Master Auditory Technology 2022 (optional subject), computer science, 1st semester
- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester
- Master Auditory Technology 2017 (optional subject), computer science, 1st semester
- Master CLS 2016 (optional subject), computer science, 3rd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master MES 2011 (optional subject), mathematics, 1st or 2nd semester
- Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester
- Master Medical Informatics 2014 (optional subject), computer science, 1st or 2nd semester
- Master CLS 2010 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester
- Master Computer Science 2012 (optional subject), specialization field bioinformatics, 3rd semester

**Classes and lectures:**

- Machine Learning (lecture, 2 SWS)
- Machine Learning (exercise, 1 SWS)

**Workload:**

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Representation learning, including manifold learning
- Statistical learning theory
- VC dimension and support vector machines
- Boosting
- Deep learning
- Limits of induction and importance of data ponderation

**Qualification-goals/Competencies:**

- Students can understand and explain various machine-learning problems.
- They can explain and apply different machine learning methods and algorithms.
- They can chose and then evaluate an appropriate method for a particular learning problem.
- They can understand and explain the limits of automatic data analysis.

**Grading through:**

- Oral examination

**Responsible for this module:**

- [Prof. Dr.-Ing. Erhardt Barth](#)

**Teacher:**

- [Institute for Neuro- and Bioinformatics](#)
- [Prof. Dr.-Ing. Erhardt Barth](#)
- [Prof. Dr. rer. nat. Thomas Martinetz](#)

**Literature:**

- Chris Bishop: Pattern Recognition and Machine Learning - Springer ISBN 0-387-31073-8
- Vladimir Vapnik: Statistical Learning Theory - Wiley-Interscience, ISBN 0471030031

**Language:**

- English, except in case of only German-speaking participants



**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- None

Module exam(s):

- CS5450-L1: Machine Learning, oral examination, 100% of module grade

<b>PY1100-KP07 - Developmental Psychology (EP)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 7
<b>Course of study, specific field and term:</b>		
<ul style="list-style-type: none"> <li>• Bachelor Psychology 2027 (compulsory), psychology, 1st semester</li> <li>• Bachelor Psychology 2016 (compulsory), psychology, 1st semester</li> <li>• Master Media Informatics 2020 (optional subject), psychology, Arbitrary semester</li> <li>• Bachelor Occupational Therapy 2018 (optional subject), psychology, 3rd or 5th semester</li> <li>• Master Media Informatics 2014 (optional subject), psychology, Arbitrary semester</li> <li>• Bachelor Psychology 2020 (compulsory), psychology, 1st semester</li> </ul>		
<b>Classes and lectures:</b>		<b>Workload:</b>
<ul style="list-style-type: none"> <li>• lecture in Developmental Psychology (lecture, 2 SWS)</li> <li>• course in Developmental Psychology (seminar, 2 SWS)</li> </ul>		<ul style="list-style-type: none"> <li>• 150 Hours private studies and exercises</li> <li>• 60 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b>		
<ul style="list-style-type: none"> <li>• Core concepts, theories and methods in developmental psychology</li> <li>• Physical development, cognitive development, Piaget, information processing theory, attachment theories, psychosocial development, moral</li> <li>• Basic scientific approaches and empirical findings on selected aspects of lifespan development and contextual factors</li> <li>• Prenatal development</li> <li>• Infancy and toddlerhood</li> <li>• Early and middle childhood</li> <li>• Adolescence</li> <li>• Early and middle adulthood</li> <li>• Old age and death</li> </ul>		
<b>Qualification-goals/Competencies:</b>		
<ul style="list-style-type: none"> <li>• Students will know how to explain and interpret findings in developmental psychology on the basis of different theoretical views</li> <li>• Students will be able to infer expert knowledge to specific developmental issues</li> <li>• Students will be able to generate hypotheses in order to explain and predict research questions in developmental psychology</li> <li>• Students will learn how to assess the validity of empirical studies concerning a variety of problems in developmental psychology</li> </ul>		
<b>Grading through:</b>		
<ul style="list-style-type: none"> <li>• written exam</li> </ul>		
<b>Responsible for this module:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. nat. Nico Bunzeck</a></li> </ul>		
<b>Teacher:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Department of Psychology</a></li> <li>• <a href="#">Prof. Dr. rer. nat. Nico Bunzeck</a></li> <li>• <a href="#">Dr. rer. biol.hum. Tineke Steiger</a></li> </ul>		
<b>Literature:</b>		
<ul style="list-style-type: none"> <li>• Robert S. Feldman: Entwicklungspsychologie - Pearson, 2024</li> <li>• Arnold Lohaus, Marc Vierhaus, Sakari Lemola: Entwicklungspsychologie des Kindes- und Jugendalters - Springer Nature, 2024</li> <li>• Martin Pinquart, Gudrun Schwarzer, Peter Zimmermann: Entwicklungspsychologie Kindes- und Jugendalter (2nd ed.) - Hogrefe, 2018</li> </ul>		
<b>Language:</b>		
<ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b>		



Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- None

Module examination(s):

- PY1100-L1: Developmental Psychology, written exam, 90min, 100% of the module grade

<b>PY2905-KP04, PY2905 - Emotion Regulation (Emreg)</b>		
<b>Duration:</b>	<b>Turnus of offer:</b>	<b>Credit points:</b>
1 Semester	each winter semester	4
<b>Course of study, specific field and term:</b>		
<ul style="list-style-type: none"> <li>• Bachelor Psychology 2027 (optional subject), psychology, Arbitrary semester</li> <li>• Master Media Informatics 2014 (optional subject), psychology, 3rd semester at the earliest</li> <li>• Master Media Informatics 2020 (optional subject), psychology, Arbitrary semester</li> <li>• Bachelor Psychology 2016 (optional subject), psychology, 3rd semester at the earliest</li> <li>• Bachelor Psychology 2020 (optional subject), psychology, 3rd semester at the earliest</li> </ul>		
<b>Classes and lectures:</b>		<b>Workload:</b>
<ul style="list-style-type: none"> <li>• course in emotion regulation (seminar, 2 SWS)</li> </ul>		<ul style="list-style-type: none"> <li>• 90 Hours private studies and exercises</li> <li>• 30 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b>		
<ul style="list-style-type: none"> <li>• Emotion regulation: Basics and theoretical models</li> <li>• Clinical diagnostics of skills for regulating emotions</li> <li>• Stress management and emotion regulation</li> <li>• Comparison of different strategies for regulating emotions</li> <li>• Relevance of emotion regulation for various mental disorders</li> <li>• Therapeutic interventions to enhance the levels of adaptive emotion regulation skills</li> </ul>		
<b>Qualification-goals/Competencies:</b>		
<ul style="list-style-type: none"> <li>• Students are able to define basic concepts of emotion regulation.</li> <li>• They are able to explain current theoretical models of emotion regulation.</li> <li>• They are able to compare different strategies of emotion regulation.</li> <li>• They are able to transfer research findings in the field of emotion regulation to clinical and therapeutic practice.</li> <li>• They are able to judge original research papers on emotion regulation</li> <li>• They are able to create a poster for a written and an oral presentation of clinical research findings.</li> </ul>		
<b>Grading through:</b>		
<ul style="list-style-type: none"> <li>• active participation in the exercises</li> </ul>		
<b>Responsible for this module:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. nat., Dipl.-Psych. Frieder Paulus</a></li> </ul>		
<b>Teacher:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Clinic of Psychiatry and Psychotherapy</a></li> <li>• <a href="#">P.Pth. Alena Senft</a></li> </ul>		
<b>Literature:</b>		
<ul style="list-style-type: none"> <li>• Gross, J.J. (Hrsg.). (2013): Handbook of emotion regulation. New York - The Guilford Press</li> </ul>		
<b>Language:</b>		
<ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b>		



Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Reading the relevant texts and active participation (50%) in the seminar

Module examination(s):

- PY2908-L1: Emotion regulation, portfolio examination, presentation, 100% of the module grade

Grade weighting:

- Reading the relevant texts and active participation (50%) in the seminar
- Designing and giving a presentation; presentation 45-60 minutes (influence on the grade: 25%)
- Organization of an interactive discussion and/or group work following the presentation; 20-35 minutes (influence on the grade: 25%)

The examination is deemed to have been completed if it is graded as at least sufficient.

<b>PY4210-KP05 - Engineering Psychology (IngPsy5)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 5
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master MES 2020 (optional subject), interdisciplinary, Arbitrary semester</li> <li>• Bachelor MES 2020 (optional subject), interdisciplinary, 3rd semester at the earliest</li> <li>• Master Media Informatics 2020 (compulsory), psychology, 1st to 3th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Engineering Psychology (lecture, 2 SWS)</li> <li>• Engineering Psychology (seminar, 1 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 105 Hours private studies and exercises</li> <li>• 45 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Fundamentals of Engineering Psychology</li> <li>• human-machine systems</li> <li>• Information Processing in Human-Technology Interaction</li> <li>• Selective attention in interface interaction</li> <li>• Situation awareness and mental models</li> <li>• Situation assessment and action selection</li> <li>• Manual control and election response tasks</li> <li>• Errors</li> <li>• Workload and stress</li> <li>• Multitasking and Resource Management</li> <li>• Automation (levels, automation trust)</li> <li>• User diversity</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students can receive, classify and use psychological engineering research contributions.</li> <li>• The students can explain central theories and findings of engineering psychology with reference to relevant questions of human-technology interaction and interface conception.</li> <li>• Students can derive design guidelines for man-machine systems from concepts and findings in engineering psychology.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• portfolio exam</li> <li>• written exam</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. nat. Thomas Franke</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. rer. nat. Thomas Franke</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• Wickens, C., Hollands, J., Banbury, S., &amp; Parasuraman, R. (2013): Engineering psychology and human performance. - Boston: Pearson</li> <li>• Proctor, R., &amp; van Zandt, T. (2018): Human Factors in Simple and Complex Systems - Boca Raton: CRC Press.</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b> <p>Prerequisites for attending the module: - None</p> <p>Prerequisites for the exam: - Successful completion of homework assignments during the semester.</p>		



<b>PY4710-KP04 - Psychology of Social Media (PsySozMed)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (optional subject), psychology, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Psychology of Social Media (lecture, 2 SWS)</li> <li>• Psychology of Social Media (exercise, 1 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies and exercises</li> <li>• 45 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• written exam</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. nat. Thomas Franke</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. rer. nat. Thomas Franke</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• :</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		

<b>PY5211-KP05 - Motivation and emotion in HCI (MotEMCI)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 5
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Entrepreneurship in Digital Technologies 2020 (optional subject), interdisciplinary competence, Arbitrary semester</li> <li>• Master Media Informatics 2020 (compulsory), psychology, 1st to 3th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Motivation and emotion in HCI (lecture, 2 SWS)</li> <li>• Motivation and emotion in HCI (exercise, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 105 Hours private studies and exercises</li> <li>• 45 Hours in-classroom work</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Fundamentals of motivation and emotion psychology</li> <li>• Methods of emotion psychology</li> <li>• Motivation as power</li> <li>• Behavioural Economics (Prospect Theory, Framing, Heuristics, Nudging)</li> <li>• Emotion theories</li> <li>• Intrinsic motivation and flow</li> <li>• Goals, Volition and Action Control</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• The students are able to present theories about motivational processes and to sketch different emotion theories in a comparative way.</li> <li>• They are able to understand the effect and dynamics of motivation in interacting with technical systems and the use of media.</li> <li>• They can assess and classify emotional processes in the use of technical systems and media and have methodological knowledge for measuring emotional reactions.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• portfolio exam</li> <li>• written exam</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. nat. Thomas Franke</a></li> </ul> <b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. rer. nat. Thomas Franke</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• V. Brandstätter, J. Schüler, R. M. Puck &amp; L. Lozo: Motivation und Emotion - Heidelberg: Springer, 2013</li> <li>• K. Rothermund &amp; A. Eder: Motivation und Emotion - Wiesbaden: VS Verlag, 2011</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b> <p>Prerequisites for attending the module: - None</p> <p>Prerequisites for the exam: - Successful completion of homework assignments during the semester.</p>		

CS4190-KP10 - In-depth module Media Informatics 1 (VpMedien1)		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 10
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (compulsory), media informatics, 1st to 3th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• In-depth module Media Informatics 1 (seminar, 2 SWS)</li> <li>• In-depth module Media Informatics 1 (project work, 4 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 150 Hours group work</li> <li>• 70 Hours written report</li> <li>• 30 Hours in-classroom work</li> <li>• 30 Hours private studies</li> <li>• 20 Hours oral presentation (including preparation)</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• presentation</li> <li>• term paper</li> <li>• Written report</li> <li>• successful addressing of the project goals</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. pol. Moreen Heine</a></li> <li>• <a href="#">Prof. Dr.-Ing. Nicole Jochems</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr.-Ing. Nicole Jochems</a></li> <li>• <a href="#">Prof. Dr. rer. pol. Moreen Heine</a></li> <li>• MitarbeiterInnen des Instituts</li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• :</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		

<b>CS4555-KP04 - Media Transmission (MediaTrans)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Entrepreneurship in Digital Technologies 2014 (optional subject), specific, Arbitrary semester</li> <li>• Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester</li> <li>• Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester</li> <li>• Master Media Informatics 2014 (compulsory), media informatics, 2nd semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• A/V Media on the Internet (lecture, 2 SWS)</li> <li>• Implementation Streaming Services (exercise, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 55 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 20 Hours exam preparation</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Audio and video compression</li> <li>• Media transmission (broadcast / streaming)</li> <li>• Communication protocols for multimedia</li> <li>• Synchronization and adaptation</li> <li>• Infrastructures (CDNs)</li> <li>• Quality of Service (QoS)</li> <li>• Applications (VoIP, IPTV, VoD)</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students have a profound understanding of the complex challenges of transmitting audiovisual media in distributed systems.</li> <li>• They are competent in applying appropriate means and techniques for A/V media on the Internet.</li> <li>• They are able to estimate the effect of individual components, e.g. compressors and protocol, quantitatively and qualitatively.</li> <li>• They can analyze, design, implement and evaluate media transmission systems.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Oral examination</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr.-Ing. Andreas Schrader</a></li> </ul> <b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute of Telematics</a></li> <li>• <a href="#">Prof. Dr.-Ing. Andreas Schrader</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• Hans W. Barz, Gregory A. Bassett: Multimedia Networks. Protocols, Design and Applications - John Wiley &amp; Sons, 1. Aufl., 2016</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• English, except in case of only German-speaking participants</li> </ul>		

<b>CS4635-KP04 - Current Research Topics in Media Informatics (ForschMedi)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Current Research Topics in Media Informatics (lecture, 1 SWS)</li> <li>• Current Research Topics in Media Informatics (seminar, 2 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Current research results and applications of techniques from the field of media informatics.</li> <li>• Current scientific methods and theories from the field of media informatics</li> <li>• Human-computer interaction as a scientific landscape</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students have in-depth knowledge of current developments and the current and future state of research in the field of media informatics, the development of modern interactive systems</li> <li>• They can integrate their own topics into current research areas and assess impact and consequences</li> <li>• They can assess ethical aspects of their work</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• project work</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• Prof. Dr. André Calero Valdez</li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• Prof. Dr. André Calero Valdez</li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• To be announced by the organizers:</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b> <p>Admission requirements for taking the module: - None</p> <p>Admission requirements for participation in module examination(s): - None</p> <p>Module examination(s): - Graded project work</p>		

<b>CS4645-KP05 - Social Media and Future Web (SMFW)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 5
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester</li> <li>• Master Media Informatics 2020 (compulsory), media informatics, 1st to 3th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Social Media and Future Web (lecture, 2 SWS)</li> <li>• Social Media and Future Web (exercise, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 30 Hours exam preparation</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>•</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Written exam or written report as announced by the examiner</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. pol. Moreen Heine</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. rer. pol. Moreen Heine</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• :</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		

CS4655-KP05 - Cross Reality (CrossRel)		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 5
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (compulsory), media informatics, 1st to 3th semester</li> <li>• Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Cross Reality (lecture, 2 SWS)</li> <li>• Cross Reality (exercise, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 30 Hours exam preparation</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Introduction and overview</li> <li>• Basic terms: Augmented Reality, Virtual Reality, Augmented Virtuality, Mixed Reality, Cross Reality, Extended Reality</li> <li>• Technical foundations</li> <li>• Perceptual foundations</li> <li>• Design space of Cross Reality</li> <li>• Design solutions &amp; interactions in cross-reality</li> <li>• Age-differentiated design of cross-reality</li> <li>• Realisation of Cross Reality</li> <li>• Quality criteria for Cross Reality</li> <li>• Outlook into the future of Cross Reality</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students know the system models and basic principles of cross reality and are familiar with applications in the form of augmented, mixed and virtual reality.</li> <li>• They are able to estimate the effort required to develop systems of this type.</li> <li>• They have an understanding of the positive and negative effects of such systems.</li> <li>•</li> <li>•</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• portfolio exam</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• Prof. Dr. rer. nat. Hans-Christian Jetter</li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• Institute for Multimedia and Interactive Systems</li> <li>• Prof. Dr. rer. nat. Hans-Christian Jetter</li> <li>• Prof. Dr.-Ing. Nicole Jochems</li> <li>• Prof. Dr. rer. pol. Moreen Heine</li> <li>• MitarbeiterInnen des Instituts</li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• Billinghurst, M., Clark, A. &amp; Lee, G.: A survey of augmented reality. - 2015, Foundations and Trends in Human-computer Interaction, 8(2 3), 73 272.</li> <li>• Jerald, J.: The VR Book: Human-Centered Design for Virtual Reality - 1st ed.). Association for Computing Machinery and Morgan &amp; Claypool, 2015</li> <li>• :</li> <li>• Preim, B., &amp; Dachselt, R.: nteraktive Systeme: Band 2: User Interface Engineering, 3D-Interaktion, Natural User Interfaces (2nd ed., Vol. 2) - Springer Vieweg, 2015</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• German, except in case of only English-speaking participants</li> </ul>		



**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- None

Module Exam(s):

- CS4655-L1 Cross Reality, practical exercises, during the semester, 50% of the module grade

- VS4655-L2 Cross Reality, oral exam, 50% of the module grade

50% of the grade for the performance of several practical exercise sheets spread over the entire semester and practically deepening the contents of the lecture.

50% of the grade for an oral examination in which questions on the lecture content are answered.

<b>CS4660-KP05 - Process Control Systems (ProzFueSy5)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 5
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (compulsory), media informatics, 1st to 3th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Process Control Systems (lecture, 2 SWS)</li> <li>• Process Control Systems (exercise, 1 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 30 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>•</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• written exam</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. phil. André Calero Valdez</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. phil. André Calero Valdez</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• :</li> <li>• :</li> <li>• :</li> <li>• :</li> <li>• :</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b>		



Prerequisites for attending the module:

- None

Prerequisites for the exam:

- Successful completion of homework assignments during the semester.

Exam(s):

- CS4660-L1 Prozessführungssysteme, Klausur, 90min, 100% der Modulnote

<b>CS4670-KP05 - Ambient Computing (AmbComp05)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 5
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (compulsory), media informatics, 1st to 3th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Ambient Computing (lecture, 3 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 85 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 20 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Current paradigms in computer technology</li> <li>• Smart components</li> <li>• Software architectures</li> <li>• Context-sensitive systems</li> <li>• Ambient Intelligence</li> <li>• Interactive ambient media systems</li> <li>• Ambient Computing Applications (AAL)</li> <li>• Ethical, Legal and Social Implications (ELSI).</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• The students are able to evaluate possibilities, concepts and challenges of Ambient Systems</li> <li>• They have an overview about current technologies and systems for developing Ambient Systems</li> <li>• They are able to follow and judge state-of-the-art research in the area of Ambient Computing</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Oral examination</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr.-Ing. Andreas Schrader</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute of Telematics</a></li> <li>• <a href="#">Prof. Dr.-Ing. Andreas Schrader</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• John Krumm: Ubiquitous Computing Fundamentals - CRC Press, 2009</li> <li>• Stefan Poslad: Ubiquitous Computing: Smart Devices, Environments and Interactions - Wiley, 2009</li> <li>• Uwe Hansman et al: Pervasive Computing - Springer, 2003</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• German and English skills required</li> </ul>		
<b>Notes:</b> <p>Admission requirements for taking the module: - None</p> <p>Admission requirements for participation in module examination(s): - None</p> <p>Module Exam(s): - CS4670-L1: Ambient Computing, oral exam, 100% of the module grade</p>		

CS4790-KP10 - In-depth module Media Informatics 1 (VpMedien2)		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 10
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (compulsory), media informatics, 1st to 3th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• In-depth module Media Informatics 2 (seminar, 2 SWS)</li> <li>• In-depth module Media Informatics 2 (project work, 4 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 150 Hours group work</li> <li>• 70 Hours written report</li> <li>• 30 Hours in-classroom work</li> <li>• 30 Hours private studies</li> <li>• 20 Hours oral presentation (including preparation)</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• presentation</li> <li>• term paper</li> <li>• Written report</li> <li>• successful addressing of the project goals</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. nat. Thomas Franke</a></li> <li>• <a href="#">Prof. Dr. rer. nat. Hans-Christian Jetter</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. rer. nat. Hans-Christian Jetter</a></li> <li>• <a href="#">Prof. Dr. rer. nat. Thomas Franke</a></li> <li>• MitarbeiterInnen des Instituts</li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• :</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		

<b>CS5110-KP12 - Media Informatics internship (MedienPrak)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> normally each term	<b>Credit points:</b> 12
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (compulsory), media informatics, 3rd semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Media Informatics internship (block practical course, 12 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 280 Hours work on project</li> <li>• 60 Hours private studies and exercises</li> <li>• 20 Hours written report</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> <li>•</li> <li>•</li> <li>•</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• continuous, successful participation in practical course</li> <li>• documentation</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr.-Ing. Nicole Jochems</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• Scientific facilities at the Universität zu Lübeck or abroad with mandatory supervision by an university lecturer</li> <li>• <a href="#">Institute of Telematics</a></li> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• German and English skills required</li> </ul>		

**CS5120-KP04 - Digital Government (DigGov)**
**Duration:**

1 Semester

**Turnus of offer:**

each summer semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester
- Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester

**Classes and lectures:**

- Digital Government (lecture, 2 SWS)
- Digital Government (seminar, 1 SWS)

**Workload:**

- 45 Hours in-classroom work
- 35 Hours private studies
- 20 Hours written report
- 20 Hours oral presentation (including preparation)

**Contents of teaching:**

- This seminar deals with digital transformation in the public sector. It provides insight into practice and research. The spectrum of topics ranges from traditional E-Government applications to solutions in public disaster management and information and participation opportunities in the context of Open Government. Current topics such as agile software development in the public sector or AI and automated decisions are also covered.

**Qualification-goals/Competencies:**

- The students are familiar with the basic definitions of Digital Government, its application in various areas of politics and administration, and principles of the design, development and use of digital government applications
- The students are able to evaluate the potential applications of digital government as a contribution to achieving political and administrative goals as well as the challenges and limitations.
- The students are able to consider and integrate the perspectives, models and theories of the various disciplines related to Digital Government
- The students are able to present and discuss their work results
- The students can present and discuss their work results

**Grading through:**

- Oral presentation and written report

**Responsible for this module:**

- [Prof. Dr. rer. pol. Moreen Heine](#)

**Teacher:**

- [Institute for Multimedia and Interactive Systems](#)
- [Prof. Dr. rer. pol. Moreen Heine](#)

**Literature:**

- Wirtz, B. W. (Ed.). (2010): E-Government: Grundlagen, Instrumente, Strategien
- Bogumil, J., & Jann, W. (2009):. Verwaltung und Verwaltungswissenschaft in Deutschland. Einführung in die Verwaltungswissenschaft. - 2., völlig überarbeitete Auflage

**Language:**

- offered only in German

<b>CS5180-KP04 - Open Data Hackathon (OpDaHa)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2014 (optional subject), media informatics, Arbitrary semester</li> <li>• Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Open Data Hackathon (lecture, 1 SWS)</li> <li>• Open Data Hackathon (exercise, 2 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 55 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 20 Hours exam preparation</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Fundamentals of Open Government, Open Data, Open Innovation and Data Driven Government</li> <li>• Hackathons - Fundamentals and Case Studies</li> <li>• Open-Data-Plattformen</li> <li>• Open-Data-Applications</li> <li>• Methods and Tools</li> <li>• Presenting and Pitching</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Students know the fundamental definitions, concepts and forms of Open Data in context of Open Government, as well as Open Innovation in the public sector.</li> <li>• Students can discuss and evaluate the challenges and limits of Open Data and Open Innovation.</li> <li>• Students are able to design Open-Data-Applications and develop prototypes. They know the general conditions and strategies for their utilization.</li> <li>• Students are able to present and discuss their work results.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• see Notes</li> <li>• presentation</li> <li>• successful addressing of the project goals</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. pol. Moreen Heine</a></li> </ul> <b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. rer. pol. Moreen Heine</a></li> <li>• <a href="#">Dr. rer. nat. Daniel Wessel</a></li> <li>• Jan Hedtfeld</li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• Schroll, W.: Kollaborative Innovationsprozesse Hackathons in Theorie und Praxis. In Veranstaltungen 4.0 (pp. 135-154) - Springer Gabler, Wiesbaden. 2017</li> <li>• Johnson, P., &amp; Robinson, P.: Civic hackathons: Innovation, procurement, or civic engagement? - Review of policy research, 31(4), 349-357. 2014</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• German, except in case of only English-speaking participants</li> </ul>		

<b>CS5620-KP04 - Game Design (GameDe)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> every summer semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• CS5620-V Game Design (lecture, 1 SWS)</li> <li>• CS5620-S Game Design (seminar, 2 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Game design processes and game jams: Introduction to the various phases of game design, from the idea and concept development to the finalisation of the game. Special focus on the principles and challenges of a game jam, in which a game has to be developed in a short time with limited resources.</li> <li>• MDA (Mechanics, Dynamics, Aesthetics): Teaching the MDA framework, which is used to systematically analyse and design the elements of a game. Mechanics (game rules), dynamics (game behaviour and interactions) and aesthetics (player experience) are treated as key components of game design.</li> <li>• Game Loop Design: Basic principles of game loops and how to create an engaging, repetitive structure that motivates the player to keep playing. This includes the design of game mechanics, challenges and rewards within the game loop.</li> <li>• Randomness in Games: The use of random elements in games to increase game variety and challenge. Students learn how randomness can be used effectively to enrich the gaming experience without jeopardising control and balance.</li> <li>• Playtesting: The central process of testing games by players. Students learn how to conduct playtests, collect feedback and use it to improve their game. They will also learn how to identify and fix typical playtesting problems. Two joint playtest sessions will be held during the semester.</li> <li>• Procedural Content Generation: The introduction and application of algorithms that allow content (such as levels, world or game objects) to be generated automatically. Students learn how to integrate procedural techniques into their games to create varied and dynamic content.</li> <li>• Game Economics: Design of game systems with an economic approach. This includes the creation of reward mechanisms, in-game currencies, trading systems and other economic models that influence the gaming experience. In particular, the programme examines how economic aspects can be integrated into games.</li> <li>• Polish and Juice: Polishing refers to the refinement and refinement of a game to optimise the user experience. Juicing includes techniques that make a game more lively and dynamic through visual and sound effects that enhance the game mechanics. Both techniques are crucial to creating a finished and engaging game.</li> <li>• Artwork and Visual Design: Fundamental principles of game artwork, from character and environment design to UI/UX design and the visual coherence of the game. Students will learn how to align their visual design decisions with the gameplay and mood of the game.</li> <li>• Publishing and distribution: Practical aspects of game publishing. This includes uploading and sharing games on platforms such as Steam, itch.io, as well as basic game publishing strategies, including audience analysis, market research and the choice of distribution channels.</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• The students will be able to develop their own computer game.</li> <li>• They will acquire comprehensive knowledge of the various aspects of game design, from concept development to technical implementation and publication.</li> <li>• They are familiar with the methods of playtesting and the continuous improvement of games and can create a well thought-out and appealing game by learning the MDA framework and other design principles.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• presentation</li> <li>• project work</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. phil. André Calero Valdez</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. phil. André Calero Valdez</a></li> </ul>		

- MitarbeiterInnen des Instituts

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**Language:**

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**Notes:**

Admission requirements for taking the module:

- Knowledge of programming and interest in game development.
- Ideally knowledge of a game engine (Godot, Unity, Unreal Engine).

Admission requirements for participation in the module examination(s):

- Successful participation in the exercises and presentations during the semester.

Award of credit points and grading by:

- CS5620-L1: Submission of a project paper (programming project + documentation) (80%)
- CS5620-L2: Regular presentation of the results as a group in presence (20%)

- The course is organised as a GameJam. Students submit their game projects in small groups for feedback from fellow students on itch.io.
- Documentation of the project can be submitted as a VLOG or as a game design document.
- Literature and further resources will be announced in the lecture.
- Students are expected to familiarise themselves independently with the chosen game engine.
- The module does not include a written exam. Instead, the practical work and the presentation of the results are graded.

**CS5625-KP04 - Psychology of Artificial Intelligence (PsyKI)**
**Duration:**

1 Semester

**Turnus of offer:**

every summer semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester

**Classes and lectures:**

- CS5625-V Psychology of Artificial Intelligence (lecture, 1 SWS)
- CS5625-S Psychology of Artificial Intelligence (seminar, 2 SWS)

**Workload:**

- 75 Hours private studies
- 45 Hours in-classroom work

**Contents of teaching:**

- Introduction to the psychology of human-AI interaction: Basic concepts of interaction between humans and artificial intelligence (AI), in particular stages of information processing, degrees of automation, interdependence and prerequisites for human-AI cooperation
- User Experience of Explainable AI: Definition of Explainable AI and differentiation from e.g. trustworthy AI, effects of Explainable AI on the perception of trust and comprehensibility and performance, application examples and forms, in particular contrastive explanations, Shapley values, perturbation methods, process of developing psychologically based quality metrics in the context of test diagnostics, questionnaire scales and other measurement methods for evaluating good UX in the context of AI use.
- Human-AI integration and other psychologically based coupling paradigms (e.g. teaming, cooperation, partnership): Models of human-AI integration and approaches to improve integration, in particular representation of input sources, correction of cognitive goal frames, diagnosticity of results, relevant basic psychological theories on central coupling paradigms (e.g. from areas such as teamwork, perceptions of cooperativeness, partnership dynamics)
- Human supervision of AI systems: Definition of human supervision from a psychological perspective, differentiation from concepts such as control, responsibility and traceability, verification of human supervision, development of experimental paradigms in the evaluation of AI systems
- AI-based decision-making: human strategies for processing AI information, relevance of e.g. reliability information, mitigation options
- Basic psychological needs & AI use: Definition of basic human needs and connection to self-determination theory in the context of human-AI interaction, transfer to automated systems, user characteristics such as affinity for technology & automation preference
- Regulation in the context of AI & psychology: EU High-Level Expert Group, EU AI regulation, comparable laws from the USA and Canada and their assignment to psychological concepts from the module, potential career goals, scope of tasks of AI officers in organisations
- Utilisation of AI systems for psychological research: The core of the module is the development of an AI interface. By designing the system, students should generate effects that are known from human-AI research, such as overconfidence in the system. The task is to promote a theoretically derived user behaviour (e.g. always change the AI result) through the design of the system and to test the difference to the derived behaviour in a final empirical evaluation

**Qualification-goals/Competencies:**

- The students are able to evaluate the psychological effects of the design of AI systems.
- Through their design approaches, they can influence how AI systems affect users and which strategies users apply when they use AI systems.
- They have a repertoire of approaches from the field of explainable AI and human-AI cooperation as well as knowledge of suitable evaluation methods in the form of questionnaires and behavioural measures.
- They can implement adapted forms of interaction experimentally and evaluate them scientifically.
- They are able to establish the relationship between normative, ethical and legal guidelines and AI-related psychological research.

**Grading through:**

- Continuous, successful participation in seminar (incl. talk)
- project work

**Responsible for this module:**

- [Prof. Dr. rer. nat. Thomas Franke](#)

**Teacher:**

- [Institute for Multimedia and Interactive Systems](#)
- [Dr. rer. nat. Tim Schrills](#)
- [Prof. Dr. rer. nat. Thomas Franke](#)

**Literature:**

- Miller, Tim: Explanation in artificial intelligence: Insights from the social sciences - Artificial intelligence 267 (2019): 1-38
- Hoffman, R. R., Mueller, S. T., Klein, G., & Litman, J. (2023): Measures for explainable AI: Explanation goodness, user satisfaction, mental models, curiosity, trust, and human-AI performance - Frontiers in Computer Science, 5, 1096257
- Sterz, S., Baum, K., Biewer, S., Hermanns, H., Lauber-Rönsberg, A., Meinel, P., & Langer, M. (2024): On the quest for effectiveness in human oversight: Interdisciplinary perspectives - Proceedings of the 2024 ACM Conference on Fairness, Accountability, and Transparency (pp. 2495-2507)
- Schrills, T., & Franke, T. (2023): How do users experience traceability of AI systems? Examining subjective information processing awareness in automated insulin delivery (AID) systems - ACM Transactions on Interactive Intelligent Systems, 13(4), 1-34

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**Language:**

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**Notes:**

Admission requirements for taking the module:

- Knowledge of programming and interest in AI development.
- Knowledge of front-ends (e.g. Unity)

Admission requirements for participation in the module examination(s):

- Successful participation in the exercises and presentations during the semester, regular presentation of results as a group in presence
- Complete submission of the final experiment and documentation in running order

Module examination(s):

CS5625-L1: Portfolio examination = submission of project work (programming project + documentation, 80%, written exam, 90 min, 20% of the module grade)

- The course is organized as an ExperimentJam. Students submit their AI design ideas in small groups for feedback from fellow students and lecturers.
- Documentation of the project can be submitted in multimedia form, e.g. an LLM-based podcast, or as written documentation.
- Literature and further resources will be announced in the lecture.
- Students are expected to familiarize themselves independently with the experimental software to be used.
- The module does not include a written exam. Instead, the practical work and the presentation of the results will be graded.
- As part of the module, data will be collected using Prolific or a comparable platform for acquiring test subjects, so no effort is required to recruit participants.

<b>CS5630-KP04 - Safety-critical man-machine cooperation (SkMMK)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester</li> <li>• Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Safety-critical man-machine cooperation (lecture, 2 SWS)</li> <li>• Safety-critical man-machine cooperation (exercise, 1 SWS)</li> </ul>		<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Introduction</li> <li>• Safety, Security, Usable Safety</li> <li>• Usable Safety Engineering</li> <li>• Resilience Engineering</li> <li>• Ethical, legal and social implications (ELSI)</li> <li>• International and intercultural aspects</li> <li>• Artificial intelligence</li> <li>• Voice assistants</li> <li>• Human-robot-cooperation</li> <li>• Industry 4.0 and Business Continuity Management</li> <li>• Future of safety-critical human-machine cooperation</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• The students know the most important theories, models and scenarios of human-machine cooperation</li> <li>• The students can explain the particular challenges regarding designing secure and usable cooperative systems</li> <li>• The students are able to analyze, design, implement and evaluate safety-critical cooperation systems</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Written or oral exam as announced by the examiner</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. phil. André Calero Valdez</a></li> </ul> <b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. phil. André Calero Valdez</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• :</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		

**CS5650-KP04 - Computer and Media Art (CMKunst)**
**Duration:**

1 Semester

**Turnus of offer:**

each summer semester

**Credit points:**

4

**Course of study, specific field and term:**

- Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester
- Master Media Informatics 2014 (optional subject), media informatics, Arbitrary semester
- Master Computer Science 2012 (optional subject), specialization field media informatics, 2nd or 3rd semester

**Classes and lectures:**

- Computer- and Media-Art (lecture, 2 SWS)
- Computer- and Media-Art (exercise, 1 SWS)

**Workload:**

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

**Contents of teaching:**

- Introduction and Overview
- History of Technology and Art
- Introduction to the art of modernism
- Digital technology as a tool and reflected medium of CMA
- Sound and music
- Political art
- Interactive installations and environments
- Telepresence, telematics, telerobotics - body and identity
- Art & AI
- VR and AR art
- Artificial Life and Artificial Life Art
- Summary and outlook

**Qualification-goals/Competencies:**

- The students know the importance of computers and interactive media for the arts.
- they are able to understand and judge media art technologically and artistically in the cultural context.
- They understand the mutual importance of technology and art in a historical reflection.

**Grading through:**

- Regular attendance at seminars
- written homework

**Responsible for this module:**

- [Dr. Thomas Winkler](#)

**Teacher:**

- [Institute for Multimedia and Interactive Systems](#)
- [Dr. Thomas Winkler](#)

**Language:**

- offered only in German

**Notes:**

Admission requirements for taking the module:  
- None

Admission requirements for participation in module examination(s):  
- Active participation in the exercises in small groups as specified at the beginning of the semester

Module examination(s):  
- CS5650-L1 Computer and Media Art, term paper, 100% of the module grade

<b>CS5992 - Master Thesis Media Informatics (MScMedien)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each semester	<b>Credit points:</b> 30
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (compulsory), media informatics, 4th semester</li> <li>• Master Media Informatics 2014 (compulsory), media informatics, 4th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Master Thesis Media Informatics (supervised self studies, 1 SWS)</li> <li>• Colloquium (presentation (incl. preparation), 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 870 Hours research for and write up of a thesis</li> <li>• 30 Hours oral presentation and discussion (including preparation)</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Further qualifications required are subject to private studies.</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• The students can solve a complex scientific problem with the means of their profession.</li> <li>• They elaborate a sophisticated scientific work within a given time.</li> <li>• They have expertise they can apply to problems.</li> <li>• They are able to analyze, interpret and critically assess scientific literature.</li> <li>• They possess the communication skills to write down and present their scientific results in an appropriate way.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Written report</li> <li>• colloquium</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• Studiengangsleitung Medieninformatik</li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Institutes of the Department of Computer Science/ Engineering</a></li> <li>• Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges</li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• :</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• thesis can be written in German or English</li> </ul>		
<b>Notes:</b> <p>Prerequisites for attending the module: - see study programme regulations (e.g. at least 75 ECTS points have been acquired)</p>		

<b>CS4295-KP04 - Deep Learning (DEEPL)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b>		
<ul style="list-style-type: none"> <li>• Master Computer Science 2019 (optional subject), Elective, Arbitrary semester</li> <li>• Master Psychology 2016 (optional subject), Elective, Arbitrary semester</li> <li>• Master Biophysics 2023 (optional subject), Elective, Arbitrary semester</li> <li>• Master Media Informatics 2020 (optional subject), Elective, Arbitrary semester</li> <li>• Master MES 2020 (optional subject), Elective, Arbitrary semester</li> <li>• Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester</li> <li>• Master Psychology - Cognitive Systems 2027 (optional subject), psychology, Arbitrary semester</li> <li>• Master Psychology - Cognitive Systems 2022 (optional subject), psychology, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b>		<b>Workload:</b>
<ul style="list-style-type: none"> <li>• CS4295-V: Deep Learning (lecture, 2 SWS)</li> <li>• CS4295-Ü: Deep Learning (exercise, 2 SWS)</li> </ul>		<ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b>		
<ul style="list-style-type: none"> <li>• Foundations and Deep Learning Basics (Learning Paradigms, Classification and Regression, Underfitting and Overfitting)</li> <li>• Shallow Neural Networks (Basic Neuron Model, Multilayer Perceptions, Backpropagation, Computational Graphs, Universal Approximation Theorem, No-Free Lunch Theorems, Inductive Biases)</li> <li>• Optimization (Stochastic Gradient Descent, Momentum Variants, Adaptive Optimizer)</li> <li>• Convolutional Neural Networks (1D Convolution, 2D Convolution, 3D Convolution, ReLUs and Variants, Down and Up Sampling Techniques, Transposed Convolution)</li> <li>• Regularization (Early Stopping, L1 and L2 Regularization, Label Smoothing, Dropout Strategies, Batch Normalization)</li> <li>• Very Deep Networks (Highway Networks, Residual Blocks, ResNet Variants, DenseNets)</li> <li>• Dimensionality Reduction (PCA, t-SNE, UMAP, Autoencoder)</li> <li>• Generative Neural Networks (Variational Autoencoder, Generative Adversarial Networks, Diffusion Models)</li> <li>• Graph Neural Networks (Graph Convolutional Networks, Graph Attention Networks)</li> <li>• Fooling Deep Neural Networks (Adversarial Attacks, White Box and Black Box Attacks, One-Pixel Attacks)</li> <li>• Physics-Aware Deep Learning (Physical Knowledge as Inductive Bias, PINN, PhyDNet, Neural ODE, FINN)</li> </ul>		
<b>Qualification-goals/Competencies:</b>		
<ul style="list-style-type: none"> <li>• Students get a fundamental understanding deep learning basics such as backpropagation, computational graphs, and auto-differentiation</li> <li>• Students understand the implications of inductive biases</li> <li>• Students get a comprehensive understanding of most relevant deep learning approaches</li> <li>• Students learn to analyze the challenges in deep learning tasks and to identify well-suited approaches to solve them</li> <li>• Students will understand the pros and cons of various deep learning models</li> <li>• Students know how to analyze the models and results, to improve the model parameters, and to interpret the model predictions and their relevance</li> </ul>		
<b>Grading through:</b>		
<ul style="list-style-type: none"> <li>• Written or oral exam as announced by the examiner</li> </ul>		
<b>Responsible for this module:</b>		
<ul style="list-style-type: none"> <li>• Prof. Dr. Sebastian Otte</li> </ul>		
<b>Teacher:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Institute for Robotics and Cognitive Systems</a></li> <li>• MitarbeiterInnen des Instituts</li> <li>• Prof. Dr. Sebastian Otte</li> </ul>		
<b>Literature:</b>		
<ul style="list-style-type: none"> <li>• Goodfellow, I., Bengio, Y., &amp; Courville, A. (2016): Deep Learning - MIT Press. ISBN 978-0262035613</li> <li>• Prince, S. J. D. (2023): Understanding Deep Learning - The MIT Press. ISBN 978-0262048644</li> </ul>		



- Deisenroth, M. P., Faisal, A. A., & Ong, C. S. (2020): Mathematics for Machine Learning - Cambridge University Press, 2020. ISBN 978-1108470049
- Bishop, C. M. (2006): Pattern Recognition and Machine Learning - Springer. ISBN 978-0387310732
- Recent publications on the related topics:

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**Language:**

- offered only in English

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**Notes:**

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):

- CS4295-L1: Deep Learning, exam, 90 min

According to the decision of the examination board of computer science of 19.8.2024 this module can be chosen by students Master Computer Science SGO from 2019 in the area of 5th elective.

<b>CS4575-KP04 - Sequence Learning (SEQL)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> every summer semester	<b>Credit points:</b> 4
<b>Course of study, specific field and term:</b>		
<ul style="list-style-type: none"> <li>• Master Computer Science 2019 (optional subject), Elective, Arbitrary semester</li> <li>• Master Medical Informatics 2019 (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester</li> <li>• Master Psychology 2016 (optional subject), Elective, Arbitrary semester</li> <li>• Master Biophysics 2023 (optional subject), Elective, Arbitrary semester</li> <li>• Master Media Informatics 2020 (optional subject), Elective, Arbitrary semester</li> <li>• Master MES 2020 (optional subject), Elective, Arbitrary semester</li> <li>• Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester</li> <li>• Master Psychology - Cognitive Systems 2022 (optional subject), psychology, Arbitrary semester</li> <li>• Master Psychology - Cognitive Systems 2027 (optional subject), psychology, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b>		<b>Workload:</b>
<ul style="list-style-type: none"> <li>• CS4575-V: Sequence Learning (lecture, 2 SWS)</li> <li>• CS4575-Ü: Sequence Learning (exercise, 1 SWS)</li> </ul>		<ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> </ul>
<b>Contents of teaching:</b>		
<ul style="list-style-type: none"> <li>• Introduction to Sequence Learning (Formalisms, Metrics, Recapitulation of Relevant Machine Learning Techniques)</li> <li>• Recurrent Neural Networks (Simple RNN Models, Backpropagation Through Time)</li> <li>• Gated Recurrent Networks (Vanishing Gradient Problem in RNNs, Long Short-Term Memories, Gated Recurrent Units, Stacked RNNs)</li> <li>• Important Techniques for RNNs (Teacher Forcing, Scheduled Sampling, h-Detach)</li> <li>• Bidirectional RNNs and related concepts</li> <li>• Hierarchical RNNs and Learning on Multiple Time Scales</li> <li>• Online Learning and Learning without BPTT (Real-Time Recurrent Learning, e-Prop, Forward Propagation Through Time)</li> <li>• Reservoir Computing (Echo State Networks, Deep ESNs)</li> <li>• Spiking Neural Networks (Spiking Neuron Models, Learning in SNNs, Neuromorphic Computing, Recurrent SNNs)</li> <li>• Temporal Convolution Networks (Causal Convolution, Temporal Dilation, TCN-ResNets)</li> <li>• Introduction to Transformers (Sequence-to-Sequence Learning, Basics on Attention, Self-Attention and the Query-Key-Value Principle, Large Language Models)</li> <li>• State Space Models (Structured State Space Sequence Models, Mamba)</li> </ul>		
<b>Qualification-goals/Competencies:</b>		
<ul style="list-style-type: none"> <li>• Students get a comprehensive understanding of most relevant sequence learning approaches</li> <li>• Students learn to analyze the challenges in sequence learning tasks and to identify well-suited approaches to solve them</li> <li>• Students will understand the pros and cons of various sequence learning models</li> <li>• Students can implement common and custom sequence learning models for time series analysis, classification, and forecasting</li> <li>• Students know how to analyze the models and results, to improve the model parameters, and to interpret the model predictions and their relevance</li> </ul>		
<b>Grading through:</b>		
<ul style="list-style-type: none"> <li>• Written or oral exam as announced by the examiner</li> </ul>		
<b>Responsible for this module:</b>		
<ul style="list-style-type: none"> <li>• Prof. Dr. Sebastian Otte</li> </ul>		
<b>Teacher:</b>		
<ul style="list-style-type: none"> <li>• <a href="#">Institute for Robotics and Cognitive Systems</a></li> <li>• MitarbeiterInnen des Instituts</li> <li>• Prof. Dr. Sebastian Otte</li> </ul>		
<b>Literature:</b>		
<ul style="list-style-type: none"> <li>• Goodfellow, I., Bengio, Y., &amp; Courville, A. (2016): Deep Learning - MIT Press. ISBN 978-0262035613</li> <li>• Prince, S. J. D. (2023): Understanding Deep Learning - The MIT Press. ISBN 978-0262048644</li> <li>• Deisenroth, M. P., Faisal, A. A., &amp; Ong, C. S. (2020): Mathematics for Machine Learning - Cambridge University Press, 2020. ISBN</li> </ul>		

978-1108470049

- Nakajima, K., & Fischer, I. (2021): Reservoir Computing: Theory, Physical Implementations, and Applications - Cambridge University Press, 2020. ISBN 978-1108470049
- Sun, R., & Giles, C. (2001): Sequence Learning: Paradigms, Algorithms, and Applications - Springer Berlin Heidelberg. ISBN 978-3540415978
- Bishop, C. M. (2006): Pattern Recognition and Machine Learning - Springer. ISBN 978-0387310732
- Recent publications on the related topics:

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**Language:**

- offered only in English

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**Notes:**

Admission requirements for taking the module:

- None, but it is recommended to complete the course Deep Learning (CS4295-KP04) first

Admission requirements for participation in module examination(s):

- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):

- CS4575-L1: Sequence Learning, exam, 90 min

According to the decision of the examination board of computer science of 19.8.2024 this module can be chosen by students Master Computer Science SGO from 2019 in the area of 5th elective.

<b>CS4110-KP05 - Natural User Interfaces (NatUI)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each winter semester	<b>Credit points:</b> 5
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Psychology - Cognitive Systems 2022 (optional subject), psychology, Arbitrary semester</li> <li>• Master Media Informatics 2020 (compulsory), design, 1st to 3th semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Natural User Interfaces (lecture, 2 SWS)</li> <li>• Natural User Interfaces (exercise, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 30 Hours exam preparation</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Introduction in Natural User Interfaces (NUIs)</li> <li>•</li> <li>• Design of natural interaction with interactive interfaces</li> <li>• Design of natural collaboration with interactive interfaces</li> <li>• Design of natural cross device interaction</li> <li>• Design of natural interaction with Tangible User Interfaces</li> <li>• Natural interaction with body, head, and gaze tracking</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>•</li> <li>•</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• portfolio exam</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr. rer. nat. Hans-Christian Jetter</a></li> </ul>		
<b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr. rer. nat. Hans-Christian Jetter</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• :</li> <li>• :</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b> <p>Prerequisites for attending the module: - None</p> <p>Prerequisites for the exam: - None</p> <p>Exam: Natural User Interfaces Portfolio Examination, the grade for which is composed as follows: - 50% of the grade for completing a group project over the entire semester, which includes the creation of a design concept or prototype for a Natural User Interface and its written documentation. - 50% of the grade for a written exam in which questions and tasks related to the lecture content are worked on individually.</p>		

<b>CS4610-KP05 - Inclusive Design (InclDes)</b>		
<b>Duration:</b> 1 Semester	<b>Turnus of offer:</b> each summer semester	<b>Credit points:</b> 5
<b>Course of study, specific field and term:</b> <ul style="list-style-type: none"> <li>• Master Media Informatics 2020 (compulsory), design, 1st to 3th semester</li> <li>• Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester</li> </ul>		
<b>Classes and lectures:</b> <ul style="list-style-type: none"> <li>• Inclusive Design (lecture, 2 SWS)</li> <li>• Inclusive Design (exercise, 1 SWS)</li> </ul>	<b>Workload:</b> <ul style="list-style-type: none"> <li>• 75 Hours private studies</li> <li>• 45 Hours in-classroom work</li> <li>• 30 Hours exam preparation</li> </ul>	
<b>Contents of teaching:</b> <ul style="list-style-type: none"> <li>• Introduction to the subject area</li> <li>• Introduction of terminology (inclusive design, ability-based design, universal design, design for all)</li> <li>• User modelling</li> <li>• Model approaches for the user-specific design of human-technology systems</li> <li>• Differentiation between Ability-based Design and Deficit-oriented Approaches</li> <li>• Adaptive systems design and creation</li> <li>• Design and layout with the goal of universal usability</li> <li>• Ethical challenges and implications of inclusive design</li> </ul>		
<b>Qualification-goals/Competencies:</b> <ul style="list-style-type: none"> <li>• Knowledge of definitions and ethical implications of inclusive design.</li> <li>• Acquisition of skills to counteract physical, cognitive and social exclusion in the design of human-computer systems.</li> <li>• Acquisition of skills to design interactive systems based on the idea of diversity with regard to future users.</li> <li>• Acquisition of skills to design adaptive human-computer interfaces.</li> </ul>		
<b>Grading through:</b> <ul style="list-style-type: none"> <li>• Oral examination</li> </ul>		
<b>Responsible for this module:</b> <ul style="list-style-type: none"> <li>• <a href="#">Prof. Dr.-Ing. Nicole Jochems</a></li> </ul> <b>Teacher:</b> <ul style="list-style-type: none"> <li>• <a href="#">Institute for Multimedia and Interactive Systems</a></li> <li>• <a href="#">Prof. Dr.-Ing. Nicole Jochems</a></li> </ul>		
<b>Literature:</b> <ul style="list-style-type: none"> <li>• C. Nicolle &amp; J. Abasca: Inclusive Design Guidelines for HCI - 2002</li> <li>• P. Hall &amp; R. Imre: Inclusive design: Designing and Developing Accessible Environments - Taylor &amp; Francis, 2004</li> </ul>		
<b>Language:</b> <ul style="list-style-type: none"> <li>• offered only in German</li> </ul>		
<b>Notes:</b> <p>Admission requirements for taking the module:</p> <ul style="list-style-type: none"> <li>- None</li> </ul> <p>Admission requirements for participation in module examination(s):</p> <ul style="list-style-type: none"> <li>- Active participation in the exercises in small groups as specified at the beginning of the semester.</li> </ul> <p>Module Exam(s):</p> <ul style="list-style-type: none"> <li>- CS4610-L1 Inclusive Design, oral exam, 70% of the module grade</li> <li>- CS4610-L2 Inclusive Design, portfolio exam, 30% of the module grade</li> </ul>		