Technische Hochschule Ulm
University of Applied Sciences

Module descriptions for the degree program

Intelligent Systems
Master of Science (M.Sc.)

Technische Hochschule Ulm
Ulm University of Applied Sciences

vom 18.12.2019
(gültig ab 09/2020)

Content

Course abbreviation	ECTS	Language	Semester	Type	Cycle
AI	6	English	1st / 2nd	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Artificial Intelligence

Assigned to curriculum
Master Intelligent Systems

Responsible for content	Teaching staff

Classification and significance of the course, in relation to the aims of the degree program
Intelligent systems are primarily characterized by their behavior (they do something smart), not by the technology used to build them. But obviously, the design of today's intelligent systems is strongly influenced by concepts and algorithms which were developed in the field of artificial intelligence (AI). It is part of computer science and has a long tradition since the fifties of the last century. This course gives an overview about AI, provides insights in selected areas such as different agent designs, and deepens practical skills in weekly programming exercises.

Learning outcomes
Upon completion of the course, the students will be able to

Subject competence
- describe the fundamental concepts and terminology of AI,
- select appropriate search strategies to solve different kinds of problems systematically and efficiently,
- describe the syntax and semantics of selected logical languages and explain different inference mechanisms for reasoning automation,
- select and apply problem solving techniques to deal with vague and uncertain information
- design and implement intelligent agents which are able to solve complex tasks in selected example scenarios

Method competence
- analyze, model, and finally solve difficult-to-structure problems with the help of computers,
- use the agent perspective to analyze existing and design new systems
- understand AI techniques for the explicit representation and processing of knowledge, and use them to build decision-capable systems
- apply formal languages and reasoning techniques to form theories

Social and personal competence
- recognize and evaluate the limits and risks of implementing these methods in practice
- reflect upon and question the fundamental mechanisms of our own thoughts and actions
- discuss fundamental views of the question: what connects and separates human and machine problem solvers

Content
- Artificial intelligence and rational agents
- Problem-solving through searching
- Problems under boundary conditions and constraints
- Knowledge representation and inference using propositional logic
- Using first-order logic to build logical agents
- Probabilistic reasoning and Bayesian networks
- Implementing intelligent systems using the aima-java library

Literature references
- Russell, S.; Norvig, P.: Artificial Intelligence – A Modern Approach (Third Edition), Prentice Hall 2010, ISBN-13 978-0136042594
- Beierle, C.; Kern-Isberner, G.: Methoden wissensbasierter Systeme, Vieweg 2006, ISBN-13 978-3834800107

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (3 SWS), Lab work (1 SWS)

Form of academic assessment	Oral examination	Monitored assignments	none

Prerequisite course				
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	120 h	0 h	180 h

Document version	0.4	**Created**	by R. Lunde on 16.12.2019

Course abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Cycle**
AUTSYS	6	English	1st / 2nd	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Autonomous Systems

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff**

Classification and significance of the course, in relation to the aims of the degree program
This module teaches in-depth knowledge about autonomous systems in the context of *embodied intelligence* (e.g. cyber-physical systems, service robots with multimodal interaction possibilities, driverless cars). This comprises concepts, methods, and algorithms which enable technical sensory-motor systems to better cope with the complexity of open-ended real-world environments (handle uncertain information, enable context-sensitive decisions at run-time, manage skill-based task execution, perform adaptation).

Learning outcomes
Upon completion of the course, the students will be able to

Subject competence
- model uncertain sensor information and use methods for the fusion of uncertain information
- use probabilistic methods for state estimation in new scenarios
- use and adapt techniques for simultaneous localization and mapping (SLAM)
- classify implementation approaches for the functionalities of autonomous systems
- describe architectures and implementation technologies for autonomous systems like e.g. intelligent service robots, autonomous cars, etc.

Method competence
- analyze and model complex problems concerning the handling of uncertain information, in particular for perception, modeling of the environment, navigation
- select appropriate architectural patterns, frameworks and software worlds when it comes to realizing embodied intelligence

Social and personal competence
- recognize and evaluate the limits and risks in the practical implementation of these methods
- know about the state-of-the-art in ethical discussions about autonomous systems
- reflect and discuss fundamental views of the question of commonalities / differences between natural and artificial intelligence / autonomy

Content
- Advanced algorithms and methods for dealing with uncertain information
  - Probabilistic approaches for state estimation and sensor data fusion: Kalman filter, particle filter
  - Localization techniques and algorithms, simultaneous localization and mapping (SLAM)
- Realization of cognitive architectures and autonomous systems
  - Cognitive architectures, information architectures, software architectures
  - Gradual levels from automation to autonomy and related requirements on software engineering
  - Model-driven approaches to link cognitive architectures, information architectures, software models
  - Skill-based engineering, task coordination, resource management in autonomous systems
- Lab exercises using service robots
  - Hands-on lab-work with autonomous service robots (e.g. Robotino)

Literature references
- S. Thrun, W. Burgard, D. Fox: Probabilistic Robotics, MIT Press, 2005, ISBN 0-262-20162-3
- R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza: Introduction to Autonomous Mobile Robots, 2nd Edition, Intelligent Robotics and Autonomous Agents series, 2011, ISBN 978-0-262-01535-6
- D. L. Hall, J. Llinas: Handbook of multisensory data fusion, CRC Press, 2001, ISBN 0-8493-2379-7
- D. Brugali: Software Engineering for Experimental Robotics, STAR series, volume 30, Springer, 2007, ISBN 3-540-68949-4
- https://robmosys.eu/wiki/, https://wiki.servicerobotik-ulm.de/start

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (3 SWS), Lab work (1 SWS)		
Form of academic assessment	Oral examination	**Monitored assignments**	none

Prerequisite course				
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	120 h	0 h	180 h

Document version	0.4	**Created**	by Ch. Schlegel on 16.12.2019

Module abbreviation ASE	**ECTS** 6	**Language** English	**Semester** 1st / 2nd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☑ Summer semester ☐ Winter semester

Module title
Advanced Software Engineering

Assigned to curriculum
Master Intelligent Systems

Assigned classes
Model-Driven Development, Software Quality

Module responsibility	**Teaching staff**

Classification and significance of the module, in relation to the aims of the degree program
Module on advanced software methods and software tools for the realization and quality assurance of complex intelligent systems, with a focus on model-driven approaches and software quality. This takes into account that in computer science these topics play a consistently important role in the management of complexity.

Learning outcomes
Upon completion of the module, the students will be able to

Subject competence
- apply the concepts and methods of model-driven software development and software quality assurance
- adapt an example toolchain from modeling to code generation
- adequately estimate the measures required to achieve the quality goals and to use the associated tools appropriately.

Method competence
- discuss the subject knowledge using practical problems, analyze problems and synthesize their own solution approaches
- use and adapt product and process-oriented software quality assurance methods

Social and personal competence
- appreciate the significance of model-based software development and competently represent its issues
- appreciate the significance of systematic quality assurance for the success of the project, and to competently represent quality assurance concerns in a project environment.

Content
- Concepts, methods and tools of model-driven software development
- Software quality assurance concepts, methods and tools

Literature references

- M. Brambilla, J. Carbot, M. Wimmer: Model-Driven Software Engineering in Practice, Morgan & Claypool, 2017, ISBN 1681732335
- T. Stahl, M. Völter: Model-Driven Software Development: Technology, Engineering, Management, Wiley, 2008, ISBN 0470025700
- M. Völter: DSL Engineering. Designing, Implementing and Using Domain-Specific Languages, 2013, ISBN 1481218581
- OMG: Specifications Catalog – Modeling Category, https://www.omg.org/spec/category/modeling/
- The Eclipse Foundation: Eclipse Modeling Project, https://www.eclipse.org/modeling/
- T. Parr: Language Implementation Patterns: Techniques for Implementing Domain-Specific Languages, O'Reilly, 2010, ISBN 193435645X
- P. Liggesmeyer: Software-Qualität. 2. Aufl., Spektrum Akademischer Verlag, 2009
- D.W. Hoffmann: Software-Qualität. Springer, 2008
- M. Utting: Practical Model-Based Testing. Morgan Kaufmann, 2007
- D.A. Peled: Software Reliability Methods. Springer, 2001
- F. Nielson, H.R. Nielson, Ch. Hankin: Principles of Program Analysis. Springer, 1999
- B. Berard u.a.: Systems and Software Verification – Model-Checking Techniques and Tools. Springer 2001
- M.B. Chrissis, M. Konrad, S. Shrum: CMMI for Development: Guidelines for Process Integration and Product Improvement.3rd ed., Addison-Wesley Longman, 2011

Other literature may be specified as part of the currently relevant course

Form of academic assessment	Oral examination		**Monitored assignment**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	90 h	180 h	0 h	270 h

Assigned courses	**SWS**	**ECTS**	**Teaching and learning form**
Model-Driven Development	2	3	Lectures with integrated exercises (2 SWS)
Software Quality	2	3	Lectures with integrated exercises (2 SWS)

Document version	0.3	**Created**	by P. Graf on 13.12.2019	

Course abbreviation	ECTS	Language	Semester	Type	Cycle
MOD	3	English	1st / 2nd	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Model-Driven Development

Assigned to curriculum
Master Intelligent Systems

Responsible for content	Teaching staff

Classification and significance of the course, in relation to the aims of the degree program

Engineering intelligent systems means to manage complexity during development, manufacturing and maintenance of large software systems. Besides separating roles and view-points, one common strategy is to apply abstractions. Model-driven software and systems development (MDSE, MDSD) aims to provide approaches, methodologies and tools to make the development of software and systems more effective, efficient and robust through following a model-centric approach. It does so by either offering suitable language abstractions, or by providing the means to define own domain-specific languages to create models in textual and diagrammatic form. Models then can be (automatically) analyzed, interpreted and transformed, thus becoming first-class artefacts in the development process.

Learning outcomes
Upon completion of the course, the students will be able to

Subject competence

- develop custom textual and diagrammatic domain specific languages and use the UML for model-driven scenarios
- develop model-to-text and model-to-model transformations
- adapt one example toolchain including modeling, language creation, code generation, model transformation, as well as constraints modeling and verification

Method competence

- discuss the subject knowledge using practical problems, analyze problems and synthesize their own solution approaches

Social and personal competence

- appreciate the significance of model-based software development and competently represent its issues

Content

Lectures cover a broad range of concepts, methods and tools for model-driven software development. In addition, important focus lies on allowing students to get practical experience with all discussed technologies.

- Introduction to model-based and model-driven development: modeling languages, aspects of a model-driven approach, GPL vs DSL, tool platforms (e.g. EMP, MPS)
- Meta-modeling: abstract vs concrete syntax, serialization with XMI
- Concrete syntax: textual (parser-based, projective) and diagrammatic (visual variables, diagram interchange), options for defining and realizing editors
- Constraints using OCL
- Model-to-Text Transformations
- Model-to-Model Transformations: in-place vs out-place, concepts, syntax and execution
- UML-based MDSD: UML metamodel, profiles…
- Model-Management, MDSD in the devopment process, DSL engineering
- Selected applications (f.e. in automotive electronics engineering)

Literature references

- M. Brambilla, J. Carbot, M. Wimmer: Model-Driven Software Engineering in Practice, Morgan & Claypool, 2017, ISBN 1681732335
- T. Stahl, M. Völter: Model-Driven Software Development: Technology, Engineering, Management, Wiley, 2008, ISBN 0470025700
- M. Völter: DSL Engineering. Designing, Implementing and Using Domain-Specific Languages, 2013, ISBN 1481218581
- OMG: Specifications Catalog – Modeling Category, https://www.omg.org/spec/category/modeling/
- The Eclipse Foundation: Eclipse Modeling Project, https://www.eclipse.org/modeling/
- T. Parr: Language Implementation Patterns: Techniques for Implementing Domain-Specific Languages, O'Reilly, 2010, ISBN 193435645X

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures with integrated exercises and lab work (2 SWS)			
Form of academic assessment			**Monitored assignments**	none
Prerequisite course				
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	60 h	0 h	90 h

Document version	0.2	**Created**	by P. Graf on 13.12.2019

Course abbreviation SWQ	**ECTS** 3	**Language** English	**Semester** 1st / 2nd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☑ Summer semester ☐ Winter semester

Course title
Software Quality

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff**

Classification and significance of the course, in relation to the aims of the degree program
Quality assurance is an important cross-functional activity in the development of complex intelligent systems. Initially, this class offers an overview of the different areas of software quality assurance, then selected current topics will be examined in greater detail. Focus topics are the use of formal and model-based methods.

Learning outcomes

Subject competence

- The students understand which features are associated with software quality and have an overview of which measures can be used to achieve quality targets.
- They understand the procedures, modeling techniques and tools for model-based testing and can assess their applicability for specific testing tasks.
- They understand the fundamental methods for automated program analysis and formal correctness verification and can assess their applicability.

Method competence

- They can apply systematic testing techniques and tools for black-box and white-box tests
- They can apply and adapt formal and model-based methods and tools, in order to demonstrate formally specified properties of systems by testing, automated static analysis or verification.

Social and personal competence

- The students have developed an awareness regarding the significance systematic quality assurance has for the success of a project, and can competently represent quality assurance concerns in a project environment.

Content

- Basics: relevance of software quality assurance, product and process quality, analytical and constructive activities for quality assurance
- Inspections and reviews
- Conventional testing techniques: testing process, equivalence-class analysis, state-based testing, structural testing techniques, test automation
- Model-based testing: model-based testing process, modeling techniques, algorithms and tools for generating test cases
- Automated static program analysis: syntax-oriented checking, basic principles and applications of control flow and dataflow analysis
- Formal verification techniques: formal program verification, model checking

Literature references

- D.W. Hoffmann: Software-Qualität. Springer, 2. Aufl., 2013
- J. Tian: Software Quality Engineering, Wiley-IEEE Computer Society Press, 2005
- P. Liggesmeyer: Software-Qualität. 2. Aufl., Spektrum Akademischer Verlag, 2009
- M. Utting: Practical Model-Based Testing. Morgan Kaufmann, 2007
- T. Roßner u.a.: Basiswissen Modellbasierter Test, dpunkt.verlag, 2010
- B. Berard u.a.: Systems and Software Verification – Model-Checking Techniques and Tools. Springer 2001

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures with integrated exercises (2 SWS)		
Form of academic assessment		**Monitored assignments**	none

Prerequisite course				
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	60 h	0 h	90 h

Document version	0.5	**Updated**	by G. Schied on 16.12.2019

Module abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Cycle**
ELEM	5	German	1st / 2nd	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Module title
Elective in Economics / Management

Assigned to curriculum
Master Intelligent Systems (Elective in Economics / Management)

Module responsibility	**Teaching staff**

Classification and significance of the module, in relation to the aims of the degree program
General management expertise is essential for graduates of technically-oriented Master's degree programs. Therefore, knowledge of value-oriented business management and planning is absolutely necessary.

Learning outcomes
Depend on the selected lecture.

Content
Students can chose between several courses.

Literature references
See course descriptions.

Teaching and learning form	Seminar (4 SWS)			
Form of academic assessment	Written exam, group work, research assignment, presentations		**Monitored assignments**	Presentations, group works
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	70 h	20 h	150 h

Example courses	**SWS**	**ECTS**	**Teaching and learning form**
Unternehmensmanagement	4	5	Seminar
International Business (EN)			
Technologie- und Informationsmanagement (only SS)			
Mitarbeiterführung und Controlling (WS)			

Document version	0.1	**Updated**	by R. Lunde on 16.12.2019

Module abbreviation PROJ	**ECTS** 13	**Language** English	**Semester** 1st and 2nd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☑ Summer semester ☑ Winter semester

Module title
Project Intelligent Systems

Assigned to curriculum
Master Intelligent Systems

Module responsibility	**Teaching staff** All professors of the degree program

Classification and significance of the module, in relation to the aims of the degree program
The module is closely related to practice, with a project-related working style which is typical for Computer Science. It permits students to deepen their methodological and subject-specific knowledge according to their preferences and interests, as well as specialization in an application area of intelligent systems. Since the module is spread across two semesters, it permits an adequately broad subject area to be explored, shaped and developed, so that the project work represents the typical phases of team dynamics and technology selection, with the appropriate depth and complexity.

Learning outcomes
At the end of the module, the students will have acquired the methods and tools for realizing complex intelligent systems in a typical project-work environment, and they have in-depth and networked expertise. They will have mastered the methods for solving research-oriented and application-specific problems by means of computer science; particularly regarding the theory and practice of intelligent systems and their application areas.

Subject competence
- Analysis and design expertise: to be able to identify and structure problem areas, to develop, substantiate and evaluate solution strategies, and select technologies
- Implementation skills: to be able to implement the selected solutions, as well as developing the in-depth specialist knowledge required for this
- Technical expertise: to be able to combine knowledge from different areas and apply it in a focused way. To be able to extend, adapt and refine technologies

Method competence
- Independent familiarization with a complex challenge and ability to break it down into manageable units
- Independent development of solutions as well as the associated coordination in the team
- Independent adaptation in the implementation process as well as the associated coordination activities in the team
- Methods and tools for managing and supporting typical project phases and procedures
- Methods for presenting and defending concepts, solutions and project results

Social and personal competence
- The ability to work through a problem in groups, including the skills to communicate with people filling different roles with different expertise
- Being proficient in the procedures for interacting with other people involved in the project, during the course of determining the subject requirements, the presentation of concepts and solutions, quality assurance and, in general, the solution of any conflicts arising by the application of conflict-solution strategies
- Understand the importance of non-technical aspects for the success of a project

Content
- Working on a project over two semesters in the field of intelligent systems in groups of typically 6 persons, with the roles distributed as is common in professional practice
- Experiencing all the phases in the execution of a project, the realistic structure of which is oriented towards experiences from professional practice
- Focus on informatics aspects (algorithmic, design, realization, use) of large, complex, intelligent systems, typically related either to an application domain (service robotics, industry 4.0, autonomous driving, healthcare, business, social networks, etc.) or to foundations of intelligent systems.
- Acquiring, deepening and applying in-depth methodological and technical knowledge in intelligent systems
- A particular feature is that the challenge is worked on in a project team, with project-specific organization, implementation and planning. The specific content, procedures and methods used depend on the characteristics of the challenge under consideration.

Literature references • Project-specific literature on topical aspects and on procedure models, project management and tools will be given while the currently relevant module is ongoing				
Form of academic assessment	Laboratory work, written report, presentation (15 min)		**Monitored assignments**	Presentation (15 min)
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	150 h	180 h	390 h

Assigned courses	**SWS**	**ECTS**	**Teaching and learning form**
Project Phase 1	2	6 (WS) or 7 (SS)	Project work
Project Phase 2	2	6 (WS) or 7 (SS)	Project work

Document version	0.3	**Created**	by C. Schlegel on 12.12.2019

Course abbreviation PROJ1	**ECTS** 6 (WS) or 7 (SS)	**Language** English	**Semester** 1st	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☑ Summer semester ☐ Winter semester

Course title
Project Phase 1

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff** All professors of the degree program

Classification and significance of the course, in relation to the aims of the degree program
(see module description)

Learning outcomes
(see module description)
Subject competence
- The focus of project phase 1 is on analysis and design skills, on algorithmic, methodological and technical expertise

Method competence
- Independent familiarization with a complex challenge and ability to break it down into manageable units
- Independent development of solutions as well as the associated coordination activities in the team
- Methods and tools for managing and supporting typical project phases and procedures
- Methods for presenting and defending concepts, solutions and project results

Social and personal competence
- The ability to work through a problem in groups, including the skills to communicate with people filling different roles with different expertise
- Being proficient in the procedures for interacting with other people involved in the project, during the course of determining the subject requirements, the presentation of concepts and solutions, quality assurance and, in general, the solution of any conflicts arising by the application of conflict-solution strategies
- Understand the importance of non-technical aspects for the success of a project

Content
In project stage 1 the focus is on
- structuring a project, project management, project phases, milestones, self-organization
- process models, development methods, tools, versioning, project documentation
- analysis of the problem and design of solutions

Literature references
- Project-specific literature on topical aspects and on process models (e.g. SCRUM), project management and tools will be given during the course of the project

Teaching and learning form	Project work			
Form of academic assessment			**Monitored assignments**	Presentation (15 min)
Prerequisite course				
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	75 h	75 (WS) / 105 (SS) h	180 or 210 h

Document version	0.4	**Created**	by C. Schlegel on 12.12.2019

Course abbreviation PROJ2	**ECTS** 6 (WS) or 7 (SS)	**Language** English	**Semester** 2nd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☐ Summer semester ☑ Winter semester

Course title
Project Phase 2

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff** All lecturers

Classification and significance of the course, in relation to the aims of the degree program
(see module description)

Learning outcomes
(see module description)
Subject competence
- The focus of Project Phase 2 is on realization skills, on advancement towards domain-specific technology readiness levels and on further deepening algorithmic, methodological and technical expertise

Method competence
- Independent adaptation in the implementation process as well as the associated coordination activities in the team
- Methods and tools for managing and supporting typical project phases and procedures
- Methods for presenting and defending concepts, solutions and project results

Social and personal competence
- The ability to work through a problem in groups, including the skills to communicate with people from different functions and different specialist backgrounds
- Being proficient in the procedures for interacting with other people involved in the project, during the course of determining the subject requirements, the presentation of concepts and solutions, quality assurance and, in general, the solution of any conflicts arising by the application of conflict-solution strategies
- Understanding the significance of non-subject related aspects for the success of the project

Content
Continuation of PROJ1 with a focus on
- structuring a project, project management, project phases, milestones, self-organization
- process models, development methods, tools, version administration, project documentation
- realization and advancement towards domain-specific technology-readiness levels

Literature references
- Project-specific literature on topical aspects and on process models (e.g. SCRUM), project management and tools will be given while the currently relevant module is ongoing

Teaching and learning form	Project work			
Form of academic assessment			**Monitored assignments**	
Prerequisite course	PROJ1			
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	75 h	75 (WS) / 105 (SS) h	180 or 210 h

Document version	0.4	**Created**	by C. Schlegel on 12.12.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
AML	6	English	1st / 2nd	☑ Compulsory ☐ Elective	☐ Summer semester ☑ Winter semester

Course title
Advanced Machine Learning

Assigned to curriculum
Master Intelligent Systems

Responsible for content	Teaching staff

Classification and significance of the course, in relation to the aims of the degree program
Machine Learning is fundamental to many data-driven Artificial Intelligence applications. Besides structured data and well-known algorithms, computer scientists are often faced with non-tabular data, such as images, and the need to improve performance. This course addresses these challenges by using sophisticated technologies such as Deep Learning networks and Ensemble Learning. Also other topics, such as Reinforcement Learning, will enable students to solve advanced machine learning tasks when out-of-the-box solutions are not sufficient.

Learning outcomes
Upon completion of the course, the students will be able to

Subject competence
- understand different deep learning architectures
- use algorithms to learn from unstructured data, such as images and text
- implement machine learning methods for real-world tasks and validate the results
- utilize ensemble methods for improving classification results
- address learning tasks with cumulative and delayed rewards

Method competence
- apply machine learning using the CRISP-DM process model
- select appropriate pre-processing and/or models for unstructured data
- critically discuss the results with respect to performance, overfitting and statistical significance

Social and personal competence
- reflect the possibilities and limits of machine learning

Content
- Deep Learning Networks (e.g. RNNs, LSTMs, CNNs)
- Learning from unstructured data (e.g. Text Mining, images, Sentiment Analysis)
- Performance measures
- Bagging, Boosting and Ensemble Learning
- Reinforcement Learning

Literature references
- Trevor Hastie et al.: *The Elements of Statistical Learning*, 2nd Edition, Springer, 2009.
- Duda, Hart, Stork: *Pattern Classification*, 2nd Edition, Wiley, 2000.
- Goodfellow, Bengio, Courville: *Deep Learning,* MIT Press, 2017.

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (2 SWS), Lab work (2 SWS)		
Form of academic assessment	Coursework, Final Quiz	**Monitored assignments**	rolling
Prerequisite course	none		

Course scope	Time present	Self-study	Practical time	Total time
	60 h	120 h	0 h	180 h

Document version	1.0	Created	by M. Goldstein on 17.12.2019

Course abbreviation AAIS	**ECTS** 6	**Language** English	**Semester** 1st / 2nd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☐ Summer semester ☑ Winter semester

Course title
Selected Topics of Intelligent Systems

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff** All professors of the degree program

Classification and significance of the module, in relation to the aims of the degree program
The module guides students towards independent scientific working. They familiarize themselves and in-depth with a selected topic in the field of intelligent systems according to individual interests and preferences. Topics on foundations of intelligent systems and topics on application areas of intelligent systems are equally suited.

Learning outcomes
After completing the module, the students will be able to interpret sophisticated scientific literature and convincingly present and defend complex subjects, both orally and in writing.

Subject competence
- Extended professional expertise through exemplary deepening in a selected topic of intelligent systems
- Extended analytical competencies through acquainting oneself with a cutting-edge topic in research and development in intelligent systems
- In-depth interdisciplinary expertise in intelligent systems by connecting current topics from research and development with application domains

Method competence
- Improve proficiency in independent work with sophisticated scientific literature (interpreting, questioning, researching, summarizing)
- Increased skills in writing, publishing and presenting scientific work

Social and personal competence
- Skills to present complex content convincingly, both orally and in writing
- Ability for critical assessments
- Ability to correctly handle one's own and third-party intellectual property (ideas, sources, results, etc.)
- Time management (the balance between the available resources and the achievable quality)

Content
The participants will work independently on a challenging scientific topic, creating a written report and presenting the results. This involves the use of scientific methods and techniques. The topics can complement and deepen the project work of the project module.
- Basic principles of scientific work as well as scientific working methods
- Literature research – reading, taking excerpts and evaluating scientific literature
- Draw up of scientific reports and publications
- Rules for quoting, plagiarism, cataloging and administrating scientific work
- Presentation and speaking skills for scientific events
- Working with paper submission and review systems, e.g. EasyChair, as well as writing reviews

Literature references
- Further information will be given by the topic during the course

Teaching and learning form	Seminar (4 SWS)			
Form of academic assessment	Written report, presentation (30 min)		**Monitored assignments**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	120 h	0 h	180 h

Document version	0.3	**Created**	by C. Schlegel on 12.12.2019

Course abbreviation	**ECTS**	**Language**	**Semester**	**Type**	**Cycle**
SDS	7	English	1st / 2nd	☑ Compulsory ☐ Elective	☐ Summer semester ☑ Winter semester

Course title
Secure Distributed Systems

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff**

Classification and significance of the module, in relation to the aims of the degree program
The module provides necessary fundamentals for creating large intelligent systems. These are typically distributed systems, so that distributed systems methods form the technical basis when designing and implementing interconnected intelligent systems.

Learning outcomes
Upon completion of the course, the students will be able to
Subject competence
- adapt and apply the basic building blocks and algorithms of a distributed application, such as, for example, logical time, distributed locking and update protocols
- analyze and solve distributed system questions and problems – such as replication, fault tolerance, security and consistency
- be able to use selected middleware systems and web technologies, and use these sufficiently well to implement a distributed information system

Method competence
- analyze a distributed information system, plan a new one and implement it practically

Social and personal competence
- in discussions with others, work out results together and present them

Content
- Introduction and requirements
- Types of communication
- Middleware structures
- Name services
- Synchronization
- Consistency and replication
- Fault tolerance
- Cloud and Web technologies
- Selected topics of current development and research projects.

Literature references
- Distributed Systems: 1. Februar 2017 Maarten van Steen, Andrew S. Tanenbaum
  ISBN-978-1543057386

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (3 SWS), Lab work (2 SWS)			
Form of academic assessment	Written examination		**Monitored assignments**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	75 h	135 h	0 h	210 h

Document version	1.1	**Created**	by S. Traub on 18.12.2019

Module abbreviation ELSP	**ECTS** 6	**Language** English German	**Semester** 1st / 2nd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☐ Summer semester ☑ Winter semester
Module title Electives for specialization					
Assigned to curriculum Master Intelligent Systems					
Module responsibility		**Teaching staff** (see courses)			
Classification and significance of the module, in relation to the aims of the degree program The module serves to deepen the students' methodological and subject-specific knowledge according to individual preferences and interests, as well as specializing in an application area of Intelligent Systems.					
Learning outcomes • Expertise in advanced fields of computer science and computer science applications, with a focus on Intelligent Systems.					
Content • Students select two courses with 3 ECTS or one course with 6 ECTS from the elective module catalog for the Intelligent Systems Master's degree program.					
Literature references • Literature references will be given during the individual courses					

Form of academic assessment	Written examination (section 28 of the examination regulations)		**Monitored assignments**	none
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	120 h	0 h	180 h

Example courses	**SWS**	**ECTS**	**Teaching and learning form**
Discrete Event-Based System Simulation	2	3	Lectures (1.5 SWS), Lab work (0.5 SWS)
Ubiquitous Computing	2	3	Lectures (1 SWS), Lab work (1 SWS)
IT Law	2	3	Lectures (2 SWS)
Navigation for Medical Interventions	2	3	Lectures (2 SWS)
and more (see section 28 for the specification of subject-specific elective modules by the Faculty)			

Document version	0.4	**Created**	by R. Lunde on 16.12.2019

Module abbreviation MTHE	**ECTS** 30	**Language** German English	**Semester** 3rd	**Type** ☑ Compulsory ☐ Elective	**Cycle** ☑ Summer semester ☑ Winter semester

Module title
Master Thesis

Assigned to curriculum
Master Intelligent Systems

Module responsibility	**Teaching staff** All professors of the degree program

Classification and significance of the module, in relation to the aims of the degree program
Independent scientific working over a longer period of time

Learning outcomes
Acquire and demonstrate the ability to carry out scientific work at a sophisticated level independently but supervised, within a given time, by the example of a complex problem in the field of intelligent systems, by using the acquired knowledge, scientific methods and insights. This includes the classification of the results in subject-specific and cross-subject contexts and their presentation in the form of a scientific thesis. The student can present and defend the work in front of an expert audience.

Content
The Master's thesis is a theoretical, software-related, empirical and/or experimental thesis, on a topic from the field of Intelligent Systems. The application of a scientific approach and methodology is required in the execution of the work. The student must proceed systematically, analytically and with methodological correctness. The thesis must be argued logically and succinctly; the work must be goal-oriented and time-critical. The results must be presented in the correct form and the student must be able to defend them convincingly. The work generally includes the following phases:

- Analyze the problem and define the topic
- Literature research in scientific sources
- Formulate the investigation approach / procedure
- Select, apply, adapt, develop, implement appropriate scientific procedures and methods
- Analyze the results, critical comparison / evaluation with the state-of-the-art, reflect upon further developments in the considered aspect of Intelligent Systems and their application
- Time and project management
- Clear and academically-appropriate presentation of the results in the form of a scientific piece of work
- Present and defend the results in front of an expert audience

In addition to the scientific thesis, the supervision includes preparation for the final presentation and defense of the thesis.

Literature references
will be provided tailored to the topic and the needs / is independently researched by the student

Teaching and learning form	Project work; self-study under guidance (scientific working, preparation of the Master's thesis)		
Form of academic assessment	written master thesis, oral presentation including a discussion defending the thesis acc. section 21 of the examination regulations	**Monitored assignments**	none

Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	840 h	0 h	900 h

Document version	0.3	**Created**	by C. Schlegel on 12.12.2019

Example Electives

Course abbreviation	ECTS	Language	Semester	Type	Cycle
IB	5	English	1st / 2nd	☐ Compulsory ☑ Elective	☑ Summer semester ☑ Winter semester

Course title
International Business

Assigned to curriculum
Master Information Systems (Elective in Economics / Management)

Responsible for content	Teaching staff

Classification and significance of the module, in relation to the aims of the degree program

Future employees and entrepreneurs need to understand the rudiments of international management, major features of the global economy, and how business is conducted in different societies. They should also be able to express themselves professionally in English - both orally and in writing.

Learning outcomes

On successful completion of the module, seminar participants will have:

Subject Competence:

- a deeper understanding of international business
- improved verbal and written presentation skills in English.

Method Competence:

- an abilty to see their technical subject and its consequences through the perspective of social science.
- an ability to understand a wide range of demanding, longer texts, and recognise implicit meaning.
- an ability to use the English language flexibly and effectively for social, academic and professional purposes.
- an ability to manage overlapping influences of different areas in international business

Social and Personal Competence:

- greater ability and confidence to discuss in English and to take part in teamwork and meetings.
- greater abilty to use English in oral presentations and in preparing written reports.

Content

The course will reach the desired competencies by dealing with the following topics:

- Trade theories
- International trade blocks and international economic institutions
- (Corporate) Culture, Interculture and Intercultural Competence
- International Business Strategies and Organization
- International Marketing
- Leadership in international business
- Financial Management / Accounting and Controlling
- Corporate Social Responsibility, ethics and compliance in international business
- Case study / management simulation of international business

The module consists of lectures, mandatory presentations by the participants, additional reading preparations, current affairs discussions and a whole-day case study.

Attendance and in-class participation are essential. The assessment is based on a written exam and an oral presentation, details are presented to all participants at the beginning of each semester.

Teaching and learning form	Seminar (4 SWS)			
Form of academic assessment	Written exam, presentations		**Monitored assignments**	Presentations, group works
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	90 h	0h	150 h

Course abbreviation	ECTS	Language	Semester	Type	Cycle
BMAN	5	German	1st / 2nd	☑ Compulsory ☐ Elective	☑ Summer semester ☐ Winter semester

Course title
Business management *(Unternehmensmanagement)*

Assigned to curriculum
Master Intelligent Systems (Elective in Economics / Management)

Responsible for content	Teaching staff

Classification and significance of the module, in relation to the aims of the degree program
General management expertise is essential for graduates of technically-oriented Master's degree programs. Therefore, knowledge of value-oriented business management and planning is absolutely necessary.
Using the method of a management simulation, participants will experience content taught in class through management in a realistic context focusing on competences as flexibility, creativity and communication skills.

Learning outcomes

Upon completion of the course, the students will be able to

Subject competence

- formulate, identify and analyze the framework conditions and most significant factors influencing the commercial success of companies;
- recognize, critically evaluate and handle complex decision situations in organizations, in the presence of uncertainty;
- develop and apply commercially-oriented, networked thinking and acting in everyday business;
- develop company goals and strategies and specify their implementation in an economical-ecological environment;
- use commercial data for practice-related insights and decisions;

Method competence

- understand and successfully use financial planning tools, balance sheets and income statements, cost and contribution margin calculations, as well as profitability and investment calculations;
- understand the background of ratings according to the Basel II standard and actively carry out business ratings;
- evaluate and develop strategic and operative success factors for organizations.

Social and personal competence

- behave correctly when handling information and make decisions under time pressure and while considering ethical aspects;
- shape the company procedures in a business, both individually and in small groups, and prepare and realize decisions with regard to operative and strategic targets.

Content

The expertise and skills listed will be acquired by studying the following topics:

1. Strategic management at a company level
2. Marketing
3. Accounting
4. Business analysis
5. Finance and forecasting
6. Production and supply chain planning
7. Controlling and cost calculation
8. Leadership and labor relations

In addition to theoretical instruction in the fields mentioned above, a haptic business game and the management simulation GENERALMANAGEMENT from Topsim will be used. During the simulation, the participants take on the role of the "management boards" in teams and lead their respective companies. All companies are in direct competition, mutually influencing each other in a market context, and the participants must take responsibility for their decisions and the results.
During the seminar short pieces of analysis and essays have to be written and special topics have to be presented and will be graded. Additionally, there will be a final written exam as well as an essay/research assignment which has to be written subsequent to the course to reflect the seminar content and apply it to a new field. In order to pass the course each part of the exam has to be passed separately. The final grade will reflect a weighted average of all parts.

Teaching and learning form	Seminar (4 SWS)			
Form of academic assessment	Written exam, group work, research assignment, presentations		**Monitored assignments**	Presentations, group works
Module scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	60 h	70 h	20 h	150 h

Document version	0.1	**Created**	by AH on 05.06.2019

Course abbreviation DES	**ECTS** 3	**Language** English	**Semester** 1st / 2nd	**Type** ☐ Compulsory ☑ Elective	**Cycle** ☐ Summer semester ☑ Winter semester

Course title
Discrete-Event System Simulation

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff**

Classification and significance of the course, in relation to the aims of the degree program
The simulation of complex systems and the concomitant abstraction and model building are important techniques which occur in diverse applications. Simulation can be employed to test and evaluate decision strategies in intelligent systems, or to optimize complex dynamic systems. The emphasis in the module is on discrete processes, such as queueing or service systems, and the method of discrete-event system simulation. Data modeling and model validation are addressed as well, using stochastic distributions and statistical tests.

Learning outcomes
Upon completion of the course, the students will be able to
Subject competence
- model, formally describe (e.g. with UML diagrams) and simulate discrete stochastic processes (e.g. with Desmo-J) in event and process-based perspectives
- model queueing systems as Markov processes and determine key performance measures
- use appropriate distributions for data modeling and validate data models as well as simulation results

Method competence
- analyze real processes, identify problem-relevant entities, events and activities, and model their interactions
- analyze a data set, find and validate an appropriate stochastic data model
- carry out a simulation project according to the proper methods, and critically evaluate the results

Social and personal competence
- work together in small groups to develop potential solutions to theoretical and practical problems

Content
- Modeling: Markov processes, queueing systems, stochastic distributions, UML
- Method: data modeling, model validation, carrying out a simulation project
- Applications: queueing systems and operating systems, agent-based simulation

Literature references
- Jerry Banks et al.: *Discrete-Event System Simulation*, 5. Ed., Pearson New International 2013.
- Averill M. Law: *Simulation Modeling and Analysis*, 5. Ed., McGraw Hill 2014.
- John F. Shortle et al.: *Fundamentals of Queueing Theory*, 5. Ed., Wiley 2018.

Other literature may be specified as part of the course.

Teaching and learning form	Lectures (1.5 SWS), Lab work (0.5 SWS)		
Form of academic assessment	Written examination (section 28)	**Monitored assignments**	none
Prerequisite course	none		

Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	60 h	0 h	90 h

Document version	0.7	**Created**	by K. Lunde on 16.12.2019

Course abbreviation	ECTS	Language	Semester	Type	Cycle
ITL	3	German English	1st / 2nd	☐ Compulsory ☑ Elective	☐ Summer semester ☑ Winter semester

Course title
IT Law

Assigned to curriculum
Master Intelligent Systems

Responsible for content	Teaching staff

Classification and significance of the course, in relation to the aims of the degree program
An understanding of the legal requirements in the field of information technology, software development and Internet law as well as the legal know-how essential for conceiving and developing legally-compliant intelligent systems.

Learning outcomes
Upon completion of the course, the students will be able to
Subject competence
- describe the essential legal requirements in the development and operation of intelligent systems,
- draw case-typical judgments from selected case examples,
- use legally drawn-up consulting solutions from real-life practice on typical case examples,

Method competence
- interpret legal statements,
- discuss typical problems from real-life practice from a legal justification perspective,

Social and personal competence
- develop and present solution approaches in cooperation with others.

Content
- Overview of the field of law "IT Law"
- Effects of IT, media and copyright law on computer science
- Contract law in IT: Project contracts, test systems, supplier liability, software maintenance and outsourcing, hosting contracts
- Internet law: Telecommunications law, name and domain protection, e-commerce and online shops
- Computer/copyright and competition law: Software license models, software licensing contracts, Open-Source-Software, Digital Rights Management (DRM), protection of databases
- Data protection requirements: the right of individuals to determine the use of their private data, protection of personal data, limits of data use
- Criminal law: criminal boundaries for IT activities, procedures, product piracy

Literature references
- Computerrecht. Jochen Schneider. dtv Verlagsgesellschaft, 2018; ISBN 978-3423055628
- DSGVO/ BDSG: Datenschutz-Grundverordnung/ Bundesdatenschutzgesetz und Nebengesetze. Martin Eßer (Hrsg.). Verlag Carl Heymanns, 2018; ISBN 978-3452289902
- Handbuch EDV-Recht: IT-Recht mit IT-Vertragsrecht, Datenschutz, Rechtsschutz und E-Business. Jochen Schneider (Hrsg.). Verlag Dr. Otto Schmidt, 2017; ISBN 978-3504560942
- Governing IT Outsourcing Relationships: The roles of contract, control, and relational norms. Daniel Kuhlmann. Diplomica Verlag, 2012; ISBN 978-3842879539
- IT-Projektverträge: Erfolgreiches Management für Auftragnehmer. Christoph Zahrnt. reateSpace Independent Publishing Platform, 2013; ISBN 978-1492844433
- Medienrecht (Start ins Rechtsgebiet). Dieter Dörr und Rolf Schwartmann. Verlag C.F. Müller, 2019; ISBN 978-3811448230
- Praxis des IT-Rechts: Praktische Rechtsfragen der IT-Sicherheit und Internetnutzung. Horst Speichert. Vieweg+Teubner Verlag; 2. Auflage, 2007. ISBN-10: 3834801127, ISBN-13: 978-3834801128
- Praxishandbuch Medien-, IT- und Urheberrecht. Rolf Schwartmann (Hrsg.). Verlag C.F. Müller, 2017; ISBN 978-3811446625

Other literature may be specified.

Teaching and learning form	Lectures (2 SWS)			
Form of academic assessment	Written examination (section 28)		**Monitored assignments**	none
Prerequisite course	none			
Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	60 h	0 h	90 h

Document version	0.4	**Created**	by M. Schäffter on 08.04.2019

Course abbreviation NAMI	**ECTS** 3	**Language** English	**Semester** 2nd	**Type** ☐ Compulsory ☑ Elective	**Cycle** ☐ Summer semester ☑ Winter semester

Course title
Navigation for Medical Interventions

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff**

Classification and significance of the course, in relation to the aims of the degree program
Technical assistance systems, including applications of augmented reality (AR) enter our everyday life. Examples are navigation systems for cars and apps for mobile devices that can overlay virtual information to camera images. Medicine can also profit from such new technologies, for example diagnosis and treatment of patients can be improved. The goal of this lecture is to teach students about the basic components for navigation systems in medicine and about the main challenges regarding introduction of such systems into clinical practice.

Learning outcomes
Upon completion of the course, the students will be able to
Subject competence
- explain which technologies are required for a medical navigation system
- perform calculations which are necessary for navigation, such as transformation of coordinates and principal component analysis
- enumerate established tracking technologies and discuss their advantages and disadvantages
- explain the operating principle of a navigation systems based on a practical example, such as a system for percutaneous needle insertions
- name and discuss problems with translation of navigation systems to clinical practice

Method competence
- open medical imaging date with a viewer software and visualize it in an appropriate way (e.g., volume visualization of sliced data),
- segment anatomical structures in medical images (e.g., CT images)
- plan a navigated medical intervention on a given example

Social and personal competence
- discuss and rate given concepts in a team
- work on a given problem in a team and present the solution

Content
- Tracking technology for localization of medical instruments
- Medical imaging in the context of further processing to enable navigation during medical interventions
- 3D reconstruction for the localization of anatomical structures
- Methods for planning of medical interventions
- Registration of medical imaging data to an intraoperative scene
- Visualization of imaging and planning data by using virtual and augmented reality
- Software development for navigated medical interventions

Literature references
- F. A. Jolesz (Herausgeber), *Intraoperative Imaging and Image-Guided Therapy*, ISBN 9781461476566, Springer 2014
- Wolfgang Niederlag, Heinz U. Lemke, Gero Strauß, Hubertus Feußner (Herausgeber), *Der digitale Operationssaal*, ISBN 9783110334302, Walter de Gruyter 2014
- T. Peters and K. Cleary (Herausgeber), *Image-Guided Interventions*, ISBN 9780387738581, Springer 2008

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (2 SWS)		
Form of academic assessment	Written examination (section 28)	**Monitored assignments**	none
Prerequisite course	none		

Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	60 h	0 h	90 h

Document version	0.2	**Created**	by A. Franz on 03.04.2019

Course abbreviation UBCMP	**ECTS** 3	**Language** English	**Semester** 1st / 2nd	**Type** ☐ Compulsory ☑ Elective	**Cycle** ☐ Summer semester ☑ Winter semester

Course title
Ubiquitous Computing

Assigned to curriculum
Master Intelligent Systems

Responsible for content	**Teaching staff**

Classification and significance of the course, in relation to the aims of the degree program
The miniaturization of processors, sensors and wireless modules is leading to increasing integration and interlinking of information technology in everyday objects. On this basis, new types of intelligent systems – adapted to their situation and available everywhere – are created which do not require explicit user interaction. This module provides an understanding of the particular challenges, technologies and methods for realizing these kinds of intelligent systems.

Learning outcomes
Upon completion of the course, the students will be able to

Subject competence
- describe the fundamental properties and paradigms of ubiquitous systems
- explain the technical and algorithmic fundamentals of Ubiquitous Computing

Method competence
- assess technologies, methods and algorithms for different application areas of Ubiquitous Computing and evaluate their suitability
- develop and implement concepts for ubiquitous, context-processing applications

Social and personal competence
- present their own solution approaches in a small team and defend the results of their work

Content
- Overview of the concepts of Ubiquitous Computing
- Technological basics of ubiquitous systems:
  Wireless communication techniques; mobile sensors; identification, positioning and tracking technologies
- Methods and algorithms for distributed data processing and fusion in sensor networks
- Human-computer interfaces
- Context, situation and activity detection methods
- Small projects with mobile devices (e.g. android based mobile phones), wireless sensor nodes and depth-sensing cameras

Literature references
- Liming Chen, Chris D. Nugent: *Human Activity Recognition and Behaviour Analysis*, Springer (2019),
- Joseph J. LaViola et al.: *3D User Interfaces: Theory and Practice*, Addison Wesley (2017), ISBN 978-0134034324
- Dominique D. Guinard, Vlad M. Trifa: *Building the web of things*, Manning Publications Co. (2016), ISBN 978-1617292682
- Stefan Poslad: *Ubiquitous Computing – Smart Devices, Environments and Interactions*, John Wiley & Sons (2009), ISBN 978-0470035603
- Feng Zhao, Leonadis J. Gubias: *Wireless Sensor Networks, An Information Processing Approach*, Morgan Kaufmann Publishers Inc. (2004), ISBN-13: 978-1558609143

Other literature may be specified as part of the currently relevant course

Teaching and learning form	Lectures (1 SWS), Lab work (1 SWS)		
Form of academic assessment	Oral examination	**Monitored assignments**	none
Prerequisite course	none		

Course scope	**Time present**	**Self-study**	**Practical time**	**Total time**
	30 h	60 h	0 h	90 h

Document version	0.3	**Created**	by F. Steiper on 16.12.2019