Julius-Maximilians-
UNIVERSITÄT
WÜRZBURG

Module Catalogue

for the Subject

Computer Science

with the degree "Erweiterungsprüfung für das Lehramt an Gymnasien"

(ECTS credits)

Examination regulations version: 2025
Responsible: Faculty of Mathematics and Computer Science
Responsible: Institute of Computer Science

Contents

The subject is divided into 5
Abbreviations used, Conventions, Notes, In accordance with 6
Scientific Discipline 7
Area 1 8
Fundamentals of Programming 9
Databases 10
Software Engineering 11
Algorithms and data structures 12
Practical Course in Programming 13
Practical course in software 14
Theory of Computation 15
Artificial Intelligence 16
Area 2 17
Technical Computer Science 18
Operating Systems 19
Computer Architecture 20
Digital computer systems 21
Computer Networks and Information Transmission 22
General Compulsory Electives 23
Computer Architecture 24
Digital computer systems 25
Computer Networks and Information Transmission 26
Operating Systems 27
Practical course in hardware 28
Logic for informatics 29
Algorithmic Graph Theory 30
Interactive Computer Graphics 31
Advanced Programming 32
Computational Complexity 33
Cryptography and Data Security 34
Model-based Systems Engineering 35
3D Point Cloud Processing 36
Photogrammetric Machine Vision 37
Control Principles of Modern Communication Systems 38
Seminar - Selected Topics in Computer Science 1 39
Project Presentation 40
Autonomous Mobile Systems 41
Exact Algorithms 42
Computational Geometry 43
Approximation Algorithms 44
Automata Theory 45
Automation and Control Technology 46
Introduction to Aviation Systems 47
Introduction to Space Systems 48
Hardware-oriented programming and Fundamentals Avionics 49
Telecommunication Systems 50
Remote Sensing 52
Modeling and Simulation 53
Satellite Image processing 54
Quantum Communications 55
Deep Reinforcement Learning for Intelligent Space Systems 57
Computability Theory 58
Databases 2 59

Deductive Databases 60
Logic Programming 61
Embedded Systems 62
Virtual Prototyping of Embedded Systems 63
Systems Benchmarking 65
Theory of Machine Learning 66
Deep Learning 67
Natural Language Processing 68
Computer Vision 69
Machine Learning for Natural Language Processing 70
NLP and Text Mining 71
Multilingual NLP 72
Sustainable Mobility 73
Computer Science and Ethics 74
Machine Learning 75
Machine Learning for Networks 1 76
Machine Learning for Networks 2 78
Statistical Network Analysis 80
Image Processing and Computational Photography 82
Reinforcement Learning and Computational Decision Making 84
Music Information Retrieval 85
Operations Research 86
Information Retrieval 87
Computational Complexity II 88
Performance Evaluation of Distributed Systems 89
Introduction in AI 90
Mathematical Logic 91
Medical Informatics 92
Professional Project Management 93
Robotics 1 94
Robotics 2 95
Discrete Event Simulation 96
Energy Informatics 1 97
Software Architecture 98
Spacecraft System Analysis 99
Visualization of Graphs 100
Introduction to IT Security 101
Security of Software Systems 102
Selected Topics in Algorithms 103
Selected Topics in Theory 104
Selected Topics in Software Engineering 105
Selected Topics in Games Engineering 106
Selected Topics in IT Security 107
Selected Topics in Internet Technologies 108
Selected Topics in Intelligent Systems 109
Selected Topics in Embedded Systems 110
Selected Topics in Aerospace Engineering 111
Selected Topics in HCI 112
Selected Topics in Data Science 113
Selected Topics in Autonomous Mobile Systems 114
Selected Topics in Computer Science and Sustainability 115
Selected Topics in Computer Science 116
Multimodal User Interfaces 117
Introduction into Human-Computer Interaction 119
3D User Interfaces 120
Machine Learning (for User Interfaces) 121
Real-Time Interactive Systems 123

Digital media 1 125
Digital media 2 126
Teaching 127
Area 1 128
Computer Science Education 1 (incl. Practical Course in the Application of Computer Science Systems form an Educational Point of View) 129
Computer Science Education 2 130
Freier Bereich (general as well as subject-specific electives) 131
Computer Science 132
Exam Tutorial for the German Staatsexamen 133
Seminar Computer Science Education 134
Advanced Topics of Computer Science Education 135
Robotics in Education (practical course) 136
Practical Course on Computer Science Education 137
Hands-on Computer Science 138
Tutor activity 1 139
Tutor activity 2 140

The subject is divided into

section / sub-section	ECTS credits	starting page
Scientific Discipline	92	7
Area 1	60	8
Area 2	12	17
Technical Computer Science	10	18
General Compulsory Electives	22	23
Teaching	10	127
Area 1	10	128
Freier Bereich (general as well as subject-specific electives)	0-15	131
Computer Science		132

Abbreviations used

Course types: **E** = field trip, **K** = colloquium, **O** = conversatorium, **P** = placement/lab course, **R** = project, **S** = seminar, **T** = tutorial, **Ü** = exercise, **V** = lecture

Term: **SS** = summer semester, **WS** = winter semester

Methods of grading: **NUM** = numerical grade, **B/NB** = (not) successfully completed

Regulations: **(L)ASPO** = general academic and examination regulations (for teaching-degree programmes), **FSB** = subject-specific provisions, **SFB** = list of modules

Other: **A** = thesis, **LV** = course(s), **PL** = assessment(s), **TN** = participants, **VL** = prerequisite(s)

Conventions

Unless otherwise stated, courses and assessments will be held in German, assessments will be offered every semester and modules are not creditable for bonus.

Notes

Should there be the option to choose between several methods of assessment, the lecturer will agree with the module coordinator on the method of assessment to be used in the current semester by two weeks after the start of the course at the latest and will communicate this in the customary manner.

Should the module comprise more than one graded assessment, all assessments will be equally weighted, unless otherwise stated below.

Should the assessment comprise several individual assessments, successful completion of the module will require successful completion of all individual assessments.

In accordance with

the general regulations governing the degree subject described in this module catalogue:

LASPO2015

associated official publications (FSB (subject-specific provisions)/SFB (list of modules)):

23-Jul-2025 (2025-61)

This module handbook seeks to render, as accurately as possible, the data that is of statutory relevance according to the examination regulations of the degree subject. However, only the FSB (subject-specific provisions) and SFB (list of modules) in their officially published versions shall be legally binding. In the case of doubt, the provisions on, in particular, module assessments specified in the FSB/SFB shall prevail.

Scientific Discipline

(92 ECTS credits)

Area 1

(60 ECTS credits)

Module title			Abbreviation
Fundamentals of Programming			10-I-GdP-172-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science II		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Data types, control structures, foundations of procedural programming, selected topics of C, introduction to object orientation in Java, selected topics of C++, further Java concepts, digression: scripting languages.

Intended learning outcomes

The students possess a fundamental knowledge about programming languages (in particular Java, C and C++) and are able to independently develop average to high level Java programs.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 49 I Nr. 1 b)
§ 69 I Nr. 1 b)

Module title			Abbreviation
Databases			10-I-DB-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Relational algebra and complex SQL statements; database planning and normal forms; transaction management.

Intended learning outcomes

The students possess knowledge about database modelling and queries in SQL as well as transactions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 49 I Nr. 1 b)
§ 69 I Nr. 1 b)

Module title			Abbreviation
Software Engineering			10-I-SE-252-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science II		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Overview of software engineering, software process models with focus on the Unified Process, agile software development, requirements analysis,software architecture, object-oriented analysis and design with UML, design patterns, software testing and quality assurance, distributed systems and cloud computing

Intended learning outcomes

The students possess a fundamental theoretical and practical knowledge on the design and development of software systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 49 I Nr. 1 b)
§ 69 I Nr. 1 b)

Module title			Abbreviation
Algorithms and data structures			10-I-ADS-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Design and analysis of algorithms, recursion vs. iteration, sort and search methods, data structures, abstract data types, lists, trees, graphs, basic graph algorithms, programming in Java.

Intended learning outcomes

Students are proficient in independently designing, precisely describing and analyzing algorithms. The students know the basic paradigms for the design of algorithms and can implement them in practical programs. Students are able to estimate the runtime behavior of algorithms and prove the correctness of algorithms.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 49 I Nr. 1 a)
§ 69 I Nr. 1 a)

Module title			Abbreviation
Practical Course in Programming			10-I-PP-191-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
1-2 semester	undergraduate	Intended learning outcomes of the following module are required: 10-I-GdP. It is therefore strongly recommended to complete this before.	

Contents

The programming language Java. Independent creation of small to middle-sized, high-quality Java programs.

Intended learning outcomes

The students are able to independently develop small to middle-sized, high-quality Java programs.

Courses (type, number of weekly contact hours, language — if other than German)

P (6)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

practical examination (programming exercises, approx. 240 hours) and written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: every semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 49 I Nr. 1 c)
§ 69 I Nr. 1 d)

Module title			Abbreviation
Practical course in software			10-I-SWP-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	(not) successfully completed	10-I-PP, 10-I-SE	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	In addition, the knowledge and skills acquired in module 10-I-ADS are required. Prior attendance of this module is therefore highly recommended.	

Contents

Completion of a project assignment in groups, problem analysis, creation of requirements specifications, specification of solution components (e. g. UML) and milestones, user manual, programming documentation, presentation and delivery of the runnable software product in a colloquium.

Intended learning outcomes

The students possess the practical skills for the design, development and execution of a software project in small teams.

Courses (type, number of weekly contact hours, language — if other than German)

P (6)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

practical project (Completion of a larger software project in groups (approx. 300 hours per person) and final presentation (approx. 10 minutes per group)

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: every semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 69 I Nr. 1 d)

Module title			Abbreviation
Theory of Computation			10-I-TI-242-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Computability, decidability, countability, finite automata, regular sets, generative grammars, context-free languages, context-sensitive languages, complexity of calculations, P-NP problem, NP completeness.

Intended learning outcomes

The students possess a fundamental and applicable knowledge in the areas of computability, decidability, countability, finite automata, regular sets, generative grammars, context-free languages, context-sensitive languages, complexity of computations, P-NP problem, NP completeness.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 49 I Nr. 1 a)
§ 69 I Nr. 1 a)

Module title			Abbreviation
Artificial Intelligence			10-I-KI-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Foundations in the following areas: definition of data mining and knowledge, discovery in databases, process model, relationship to data warehouse and OLAP, data preprocessing, data visualisation, unsupervised learning methods (cluster and association methods), supervised learning (e. g. Bayes classification, KNN, decision trees, SVM), learning methods for special data types, other learning paradigms.

Intended learning outcomes

The students possess a theoretical and practical knowledge of typical methods and algorithms in the area of data mining and machine learning. They are able to solve practical knowledge discovery problems with the help of the knowledge acquired in this course and by using the KDD process. They have acquired experience in the use or implementation of data mining algorithms.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes) or
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)
§ 69 I Nr. 1 b)

Area 2

(12 ECTS credits)

Technical Computer Science

(10 ECTS credits)

Module title			Abbreviation
Operating Systems			10-I-BS-242-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XVII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Introduction to computer systems, development of operating systems, architecture principles, interrupt processing in operating systems, processes and threads, CPU scheduling, synchronisation and communication, memory management, device and file management, operating system virtualisation.

Intended learning outcomes

The students possess knowledge and practical skills in building and using essential parts of operating systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b), § 69 I Nr. 1 c)

Module title			Abbreviation
Computer Architecture			10-I-RAK-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Instruction set architectures, command processing through pipelining, statical and dynamic instruction scheduling, caches, vector processors, multi-core processors.

Intended learning outcomes

The students master the most important techniques to design fast computers as well as their interaction with compilers and operating systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)
§ 69 I Nr. 1 c): Rechnerarchitektur

Module title			Abbreviation
Digital computer systems			10-I-RAL-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Introduction to digital technologies, Boolean algebras, combinatory circuits, synchronous and asynchronous circuits, hardware description languages, structure of a simple processor, machine programming, memory hierarchy.

Intended learning outcomes

The students possess a knowledge of the fundamentals of digital technologies up to the design and programming of easy microprocessors as well as knowledge for the application of hardware description languages for the design of digital systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b), § 69 I Nr. 1 c)

Module title			Abbreviation
Computer Networks and Information Transmission			10-I-RIÜ-191-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science III		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

- Computer networks and the Internet: Structure and Mechanisms of Telecommunication
- Communication Protocols: Basic Principles and the Layer Model
- Computer and Communication Systems: Network Systems, Data Traffic in Distributed Systems and inter-network Communication
- The Internet: Important Protocols and Routing
- Architecture and Structure of Computer Networks: Network Architecture, Access Mechanisms, Flow Control and Traffic Management
- Coding Theory: Mechanisms for Error Detection and Error Correction
- Information Theory: Entropy of Data
- Digital Communication Systems: Signal Modulation

Intended learning outcomes

Students command the technical, theoretical as well as practical knowledge to understand the structure of computer networks, the Internet and communication systems for telecommunication.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b), § 69 I Nr. 1 c)

General Compulsory Electives

(22 ECTS credits)

Module title			Abbreviation
Computer Architecture			10-I-RAK-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Instruction set architectures, command processing through pipelining, statical and dynamic instruction scheduling, caches, vector processors, multi-core processors.

Intended learning outcomes

The students master the most important techniques to design fast computers as well as their interaction with compilers and operating systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)
§ 69 I Nr. 1 c): Rechnerarchitektur

Module title			Abbreviation
Digital computer systems			10-I-RAL-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Introduction to digital technologies, Boolean algebras, combinatory circuits, synchronous and asynchronous circuits, hardware description languages, structure of a simple processor, machine programming, memory hierarchy.

Intended learning outcomes

The students possess a knowledge of the fundamentals of digital technologies up to the design and programming of easy microprocessors as well as knowledge for the application of hardware description languages for the design of digital systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b), § 69 I Nr. 1 c)

Module title			Abbreviation
Computer Networks and Information Transmission			10-I-RIÜ-191-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science III		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

- Computer networks and the Internet: Structure and Mechanisms of Telecommunication
- Communication Protocols: Basic Principles and the Layer Model
- Computer and Communication Systems: Network Systems, Data Traffic in Distributed Systems and inter-network Communication
- The Internet: Important Protocols and Routing
- Architecture and Structure of Computer Networks: Network Architecture, Access Mechanisms, Flow Control and Traffic Management
- Coding Theory: Mechanisms for Error Detection and Error Correction
- Information Theory: Entropy of Data
- Digital Communication Systems: Signal Modulation

Intended learning outcomes

Students command the technical, theoretical as well as practical knowledge to understand the structure of computer networks, the Internet and communication systems for telecommunication.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b), § 69 I Nr. 1 c)

Module title			Abbreviation
Operating Systems			10-I-BS-242-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XVII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Introduction to computer systems, development of operating systems, architecture principles, interrupt processing in operating systems, processes and threads, CPU scheduling, synchronisation and communication, memory management, device and file management, operating system virtualisation.

Intended learning outcomes

The students possess knowledge and practical skills in building and using essential parts of operating systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b), § 69 I Nr. 1 c)

Module title			Abbreviation
Practical course in hardware			10-I-HWP-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Practical experiments on hardware aspects, for example in communication technology, robots or the structure of a complete microprocessor.

Intended learning outcomes

The students are able to independently review, prepare and perform experiments with the help of experiment descriptions, to independently search for additional information as well as to document and evaluate experiment results.

Courses (type, number of weekly contact hours, language — if other than German)

P (6)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

portfolio: completion of approx. 3 to 10 project assignments (approx. 250 hours total) and presentation of results (approx. 10 minutes per project)

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: every semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Logic for informatics			10-I-LOG-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Syntax and semantics of propositional logic, equivalence and normal forms, Horn formulas, SAT, resolution, infinite formula sets, syntax and semantics of predicate logic.

Intended learning outcomes

The students are proficient in the following areas: syntax and semantics of propositional logic, equivalence and normal forms, Horn formulas, SAT, resolution, infinite formula sets, syntax and semantics of predicate logic.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Algorithmic Graph Theory			10-I-AGT-152-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

We discuss typical graph problems: We solve round trip problems, calculate maximal flows, find matchings and colourings, work with planar graphs and find out how the ranking algorithm of Google works. Using the examples of graph problems, we also become familiar with new concepts, for example how we model problems as linear programs or how we show that they are fixed parameter computable.

Intended learning outcomes

The students are able to model typical problems in computer science as graph problems. In addition, the participants are able to decide which tool from the course helps solve a given graph problem algorithmically. In this course, students learn in detail how to estimate the run time of given graph algorithms.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Interactive Computer Graphics			10-I-ICG-152-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science IX		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Computer graphics studies methods for digitally synthesising and manipulating visual content. This course specifically concentrates on interactive graphics with an additional focus on 3D graphics as a requirement for many contemporary as well as for novel human-computer interfaces and computer games. The course will cover topics about light and images, lighting models, data representations, mathematical formulations of movements, projection as well as texturing methods. Theoretical aspects of the steps involved in ray-tracing and the raster pipeline will be complemented by algorithmical approaches for interactive image syntheses using computer systems. Accompanying software solutions will utilise modern graphics packages and languages like OpenGL, GLSL and/or DirectX.

Intended learning outcomes

At the end of the course, the students will have a broad understanding of the underlying theoretical models of computer graphics. They will be able to implement a prominent variety of these models, to build their own interactive graphics applications and to choose the right software tool for this task.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Advanced Programming			10-I-APR-172-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science II		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

With the knowledge of basic programming, taught in introductory lectures, it is possible to realize simpler programs. If more complex problems are to be tackled, suboptimal results like long, incomprehensible functions and code duplicates occur. In this lecture, further knowledge is to be conveyed on how to give programs and code a sensible structure. Also, further topics in the areas of software security and parallel programming are discussed.

Intended learning outcomes

Students learn advanced programming paradigms especially suited for space applications. Different patterns are then implemented in multiple languages and their efficiency measured using standard metrics. In addition, parallel processing concepts are introduced culminating in the use of GPU architectures for extremely quick processing.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Computational Complexity			10-I-KT-191-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Complexity measurements and classes, general relationships between space and time classes, memory consumption versus computation time, determinism versus indeterminism, hierarchical theorems, translation methods, P-NP problem, completeness problems, Turing reduction, interactive proof systems.

Intended learning outcomes

The students possess a fundamental and applicable knowledge in the areas of complexity measurements and classes, general relationships between space and time classes, memory consumption versus computation time, determinism versus indeterminism, hierarchical theorems, translation methods, P-NP problem, completeness problems, Turing reduction, interactive proof systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
Assessment offered: In the semester in which the course is offered and in the subsequent semester
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: Usually every 2 years

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Cryptography and Data Security			10-I-KD-191-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Private key cryptography systems, Vernam one-time pad, AES, perfect security, public key cryptography systems, RSA, Diffie-Hellman, Elgamal, Goldwasser-Micali, digital signature, challenge-response methods, secret sharing, millionaire problem, secure circuit evaluation, homomorphous encryption.

Intended learning outcomes

The students possess a fundamental and applicable knowledge in the areas of private key cryptography systems, Vernam one-time pad, AES, perfect security, public key cryptography, RSA, Diffie-Hellman, Elgamal, Goldwasser-Micali, digital signature, challenge-response method, secret sharing, millionaire problem, secure circuit evaluation, homomorphous encryption

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
Assessment offered: In the semester in which the course is offered and in the subsequent semester
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: Usually every 2 years

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Model-based Systems Engineering			10-I-MSE-252-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XI		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Practical teaching of basic concepts of system modeling and development.

Intended learning outcomes

Students have theoretical knowledge of widely used model types (e.g. state machines) and are able to model real systems with UML and implement the models as software.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
3D Point Cloud Processing			10-l-3D-152-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XVII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Laser scanning, Kinect and camera models, basic data structures (lists, arrays, oc-trees), calculating normals, k-d trees, registration, features, segmentation, tracking, applications for airborne mapping, applications to mobile mapping.

Intended learning outcomes

Students understand the fundamental principles of all aspects of 3D point cloud processing and are able to communicate with engineers / surveyors / CV people / etc. Students are able to solve problems of modern sensor data processing and have experienced that real application scenarios are challenging in terms of computational requirements, in terms of memory requirements and in terms of implementation issues.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Photogrammetric Machine Vision			10-LURI=PHOTO-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XVII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

(1) What is Photogrammetry? (2) Cameras (3) Homogeneous Coordinates (4) Camera Parameter (5) Direct Linear Transform (6) Spatial Resection (7) Relative Orientation and Fundemental Matrix (8) Epipolar Geometry (9) FE-direct (10) Iterative-Solution (11) Triangulation (12) Multiview (13) Aerial photography (14) Orthophoto (15) Finding Corresponding Points (16) Matching

Intended learning outcomes

Students understand that photogrammetry means measuring in and with photos. They have learned the steps to calculate 3D information from 2D images and are able to evaluate accuracies. The know the limits of 3D computer vision.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Control Principles of Modern Communication Systems			10-I-RK-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science III		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

The module teaches control principles in the Internet, in computer networks and modern communication systems, central and distributed mechanisms for control and data exchange, architecture and basic mechanisms in current broadband and home access networks. Simple methods of assessing performance and an introduction to traffic theory are given.

Intended learning outcomes

The students have extensive knowledge of the structure, architecture and control principles of modern communication systems and can apply the knowledge to evaluate the systems and protocols in simulations and measurements. They also get to know basic methods for theoretical analysis.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
if announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Seminar - Selected Topics in Computer Science 1			10-I-SEM1-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Independent review of a current topic in computer science on the basis of literature and, where applicable, software with written and oral presentation. The topics in modules 10-I-SEM1 and 10-I-SEM2 must come from different areas (this usually means that they are assigned by different lecturers).

Intended learning outcomes

The students are able to independently review a current topic in computer science, to summarise the main aspects in written form and to orally present these in an appropriate way.

Courses (type, number of weekly contact hours, language — if other than German)

S (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written elaboration (approx. 10 to 15 pages) and presentation (approx. 30 to 45 minutes) with subsequent discussion on a topic from the field of computer science
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Project Presentation			10-I-PV-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
2	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Presentation of a project developed by the student (e. g. Bachelor's thesis, software project) analogous to a presentation for laypersons with a knowledge of computer science at a trade fair. The project, which may also be work-in-progress, is presented with the help of a poster, a short talk and optionally a live demonstration.

Intended learning outcomes

The students are able to present a project they developed and to create the required media.

Courses (type, number of weekly contact hours, language — if other than German)

S (3)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Presentation of a self-developed project analogous to a trade fair presentation for computer science laypersons with discussion (approx. 10 to 15 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

60 h

Teaching cycle

Teaching cycle: every semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Autonomous Mobile Systems			10-LURI=AMS-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XVII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

(1) What are mobile robots? (2) Sensors (3) Sensor data processing (4) Locomotion and kinematics (5) Localization (6) Localization in maps (7) Mapping and SLAM (8) Navigation (9) Sensor data interpretation (10) Robot control architectures

Intended learning outcomes

Students know Bayesian concepts for sensor data processing for a mobile system and are able to apply the concepts to mobile robots. Derived concepts like Kalman filter, Particle filter, POMDPs, etc. are understood. They have learned the steps to build and program mobile systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IT, KI, ES, LR, GE

Workload

300 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Exact Algorithms			10-I=EA-252-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

--

Intended learning outcomes

--

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Computational Geometry			10-I=AG-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

In many areas of computer science -- for example robotics, computer graphics, virtual reality and geographic information systems -- it is necessary to store, analyse, create or manipulate spatial data. This class is about the algorithmic aspects of these tasks: We will acquire techniques that are needed to plan and analyse geometric algorithms and data structures. Every technique will be illustrated with a problem in the practical areas listed above.

Intended learning outcomes

The students are able to decide which algorithms or data structures are suitable for the solution of a given geometric problem. The students are able to analyse new problems and to come up with their own efficient solutions based on the concepts and techniques acquired in the lecture.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,HCI,GE,IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Approximation Algorithms			10-I=APA-161-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

The task of finding the optimal solution for a given problem is omnipresent in computer science. Unfortunately, there are many problems without an efficient algorithm for an optimal solution. As a result, in practice, methods are used which do not always give the optimal solution but always give good solutions. This lecture will discuss drafting and analysing techniques for algorithms which have a proven approximation quality. With the help of practical optimisation problems, the lecture will introduce students to important drafting techniques such as greedy, local search, scaling as well as methods based on linear programming.

Intended learning outcomes

The students are able to analyse easy approximation methods in terms of their quality. They understand fundamental drafting techniques such as greedy, local search and scaling as well as methods based on linear programming and are able to apply these to new problems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,IT,GE

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Automata Theory			10-I=AUT-212-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Finite automata, regular languages, star-free languages, natural equivalence relations, predicate logic with words, language acceptance through monoids, syntactic monoid, predicate logical and algebraic characterisation of regular languages and star-free languages, two-way automata.

Intended learning outcomes

The students possess a fundamental and applicable knowledge in the areas of finite automata, regular languages, star-free languages, natural equivalence relations, predicate logic with words, language acceptance through monoids, syntactic monoid, predicate logical and algebraic characterisation of regular and star-free languages, two-way automata.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
Assessment offered: In the semester in which the course is offered and in the subsequent semester
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT, IT, ES, HCI, GE

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Automation and Control Technology			10-I-AR-152-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science VII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
8	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Overview of automation systems, foundations of control technology, simple design methods, model creation, differential equations, nomenclature, transfer function, step response and realising of easy linear controllers, structure images and structure image reduction, locus curves and Bode diagrams, frequency characteristic, persistent control deviation, controller design through parameter optimisation, basics of fuzzy control, scanning systems, eigenvalue based system analysis, classification of automation and control systems, examples.

Intended learning outcomes

The students master the fundamentals of automation and control.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

240 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Introduction to Aviation Systems			10-I-LFS-172-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Physical foundations of aircraft aerodynamics, flight stability, airplane technology and structure of aircraft, foundations of aviation propulsion and suitable material.

Intended learning outcomes

The students possess the theoretical and practical knowledge necessary to correctly classify aerospace systems, correctly identify the most important system relationships, formulate requirements for new systems and do calculations for selected basic system elements.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 30 minutes).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Introduction to Space Systems			10-I-RFS-172-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

History of space flight, carrier rockets, orbits of spacecraft, environment conditions in space, special aspects of space applications, foundations of subsystems of spacecraft. Introduction to aviation systems.

Intended learning outcomes

The students possess the theoretical and practical knowledge necessary to correctly classify aerospace systems, correctly identify the most important system relationships, formulate requirements for new systems and do calculations for selected basic system elements.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 30 minutes).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Hardware-oriented programming and Fundamentals Avionics			10-LURI-HWZ-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Fundamentals of data processing for aerospace applications. Analog technology, digital technology, programming, MCU, memory, memory organization, system architecture, communication interfaces, input/output, sensors and actuators, energy system, reliability, fault tolerance. Programming of embedded systems with C.

Intended learning outcomes

Understanding of analog and digital data processing in embedded systems. Hardware design and programming. Hardware-related programming in C, knowledge of common sensors and actuators as well as input/output devices and communication interfaces.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2) + P (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 120 minutes) and practical examination in form of approx. 6 programming exercises (approx. 4 hours each), weighted 1:1
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Telecommunication Systems			10-I=TSD-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

- Introduction
- Signals and Linear Systems
- Digital Representation of Analog Signals
- Binary Baseband Modulation
- Detection of Binary Baseband Signals in Noise
- Digital Modulation
- Multicarrier Modulation
- Channel Coding
- Networks and Protocols
- Further Topics

Intended learning outcomes

Students will

- grasp the concepts and techniques of sampling, quantisation and pulse shaping for signal transmission and reception,
- learn how to detect and decode signals in the presence of noise,
- gain knowledge of higher order modulation schemes and their applications, including Quadrature Amplitude Modulation (QAM) and Frequency Shift Keying (FSK),
- understand the basics of error control coding, such as forward error correction (FEC) codes and convolutional codes, and their role in enhancing data reliability and
- become acquainted with network protocols, including the OSI model, TCP/IP protocols, and those used in wireless networks, understanding their functions and operation.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR

Workload

300 h

Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Remote Sensing			10-I=RRS-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science VIII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Remote sensing refers to the use of satellite- or aircraft-based sensor technologies to detect and classify objects on Earth, including on the surface and in the atmosphere and oceans, based on propagated signals (e.g. electromagnetic radiation). It may be split into "active" remote sensing (i.e., when a signal is emitted by a satellite or aircraft and its reflection by the object is detected by the sensor) and "passive" remote sensing (i.e., when the reflection of sunlight is detected by the sensor).

Intended learning outcomes

The students learn the basics of earth observation. They outline and explain the radiation path through the atmosphere to the object under investigation and back to the sensor. They emphasize essential characteristics of remote sensing data, sensors and platforms.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

possible majors for MA 120 Computer Science: LR,IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Modeling and Simulation			10-I-MuS-212-m01
Module coordinator		**Module offered by**	
holder of the Professorship for modeling and simulation		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Modeling and simulation play a central role in computer science and in the natural sciences for the analysis of systems. The module includes basic modeling paradigms, basics of simulation (discrete, continuous, hybrid, parallel), its implementation and evaluation.

Intended learning outcomes

The students learn the basics of various modeling formalisms and types of simulations as well as their application. They will acquire the skills to translate these systems into models for given problems and tasks, to develop simulation scenarios with suitable software, and to carry out and analyze simulation studies.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
if announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Satellite Image processing			10-LURI=SBV-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science VIII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

--

Intended learning outcomes

--

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Quantum Communications			10-I=QC-261-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

- Introduction
- Hilbert Spaces and Operators
- Quantum Mechanics
- Quantum States
- Quantum Circuit Elements
- Entanglement and Its Applications
- Quantum Key Distribution
- Quantum Channel
- Quantum Error Correction Coding
- Continuous-Variable Quantum Communications
- Further Topics

Intended learning outcomes

Students will

- develop a solid foundation in quantum information technology, including qubits, quantum gates, entanglement, and quantum measurements,
- learn about secure communications using quantum mechanics, including protocols like Quantum Key Distribution (QKD),
- gain familiarity with protocols such as quantum teleportation, superdense coding and error correction, and
- understand the effects of noise and decoherence in quantum communications and learn strategies to mitigate their impact.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR

Workload

150 h

Teaching cycle
Teaching cycle: every year, winter semester
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Deep Reinforcement Learning for Intelligent Space Systems			10-I=DRLISS-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

- Key Concepts in Reinforcement Learning
- Exact Methods for Finite Markov Decision Processes
- Tabular Reinforcement Learning
- Planning and Learning with Tabular Methods
- Approximation Methods and Deep Reinforcement Learning
- Policy Optimization
- Value-Based Methods
- Applying Reinforcement Learning and Practical Tips and Tricks
- Aerospace Applications
- Model-Based Reinforcement Learning
- Challenges
- Frontiers and Future of Deep Reinforcement Learning

Intended learning outcomes

Students understand the basics of reinforcement learning & deep reinforcement learning (model-free & model-based). They understand current challenges and unsolved problems. They are able to use standard algorithms for (continuous) control tasks and have learned about aerospace applications.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

--

Module title			Abbreviation
Computability Theory			10-I=BER-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Gödel numbering, computable functions, decidable and countable sets, halting problem, m-reducibility, creative and productive sets, relative computability, Turing reduction, countable degrees, arithmetic hierarchy.

Intended learning outcomes

The students possess a fundamental and applicable knowledge in the areas of Gödel numbers, countable functions, decidable and countable sets, halting problem, m-reducibility, creative and productive sets, relative computability, Turing reduction, countable degrees, arithmetic hierarchy.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
Assessment offered: In the semester in which the course is offered and in the subsequent semester
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits):
AT,SE,IT,KI,GE

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Databases 2			10-I=DB2-242-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Data warehouses and data mining; web databases; introduction to Datalog.

Intended learning outcomes

The students have advanced knowledge about relational databases, XML and data mining.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE, KI, HCI

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Deductive Databases			10-I=DDB-212-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Syntax and semantics of definite and normal logic programs; Model, proof, and fixpoint theory; Connection to relational databases; Evaluation methods for Datalog; Negation and stratification; Structural properties of logic programs: recursion, equivalence, transformation; Outlook on disjunctive logic programs.

Intended learning outcomes

The students have fundamental and practicable knowledge about Datalog (including negation).
They are able to compactly implement declarative programs in Datalog and to compare existing programs w.r.t. their equivalence and other properties.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,SE,IT,KI

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Logic Programming			10-I=LP-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science VI		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Logic-relational programming paradigm, top-down evaluation with SLD(NF) resolution. Introduction to the logic programming language Prolog: recursion, predicate-oriented programming, backtracking, cut, side effects, aggregations. Connection to (deductive) databases. Comparison with Datalog, short introduction of advanced concepts like constraint logic programming.

Intended learning outcomes

The students have fundamental and practicable knowledge of logic programming. They are able to implement compact and declarative programs in Prolog, and to compare this approach to the traditional imperative programming paradigm.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,SE,IT,KI

Workload

150 h

Teaching cycle

Teaching cycle: Usually every 2 years

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Embedded Systems			10-I=ES-231-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Models of embedded systems, implementation methods (ASIC, AISIP, micro controller), verification of embedded systems, implementation planning static, periodic and dynamic, binding problems, hardware synthesis, software synthesis.

Intended learning outcomes

The students are familiar with the technical possibilities for the design of embedded systems and master the most important techniques for the modelling, verification and optimisation of such systems in hardware and software.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,SE,ES,LR,GE

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Virtual Prototyping of Embedded Systems			10-I=VPES-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Today's companies have to deal with complex hardware architectures such as heterogeneous multi-core systems. Therefore, new development tools and approaches such as virtual prototyping are needed for efficient and fast design on electronic system level. In our research, we use SystemC and gem5 based virtual platforms for a thorough design space exploration on software and hardware level.

- Introduction to virtual prototyping and virtual product development methodology for embedded systems
-
- System models and specification
- Hardware/Software co-development with virtual prototyping
- Modelling with cycle accurate SystemC
- Modelling on higher level of abstraction with Transaction Level Modeling (TLM)
- Modelling of embedded processors with gem5
- Design space exploration for embedded systems with virtual prototypes

Intended learning outcomes

- Understanding advantages of novel virtual product development
- Finding the right level of abstraction for a specific problem
- Develop a feeling for the tradeoff between accuracy and simulation speed
-
  - Hardware/Software co-development
  - Design space exploration

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): ES

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Systems Benchmarking			10-I=SB-252-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science II		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Benchmarking has become a major discipline in science and technology as a driver of product quality, efficiency, and sustainability. Reliable and fair benchmarks enable educated decisions and play an important role as evaluation tools during system design, development, and maintenance. In research, benchmarks play an integral part in the evaluation and validation of new approaches and methodologies. The course introduces the foundations of benchmarking as a discipline, covering the three fundamental elements of each benchmarking approach: metrics, workloads, and measurement methodology. More specifically the following topics are covered: benchmarking basics, metrics, statistical measurements, experimental design, workloads, measurement tools, operational analysis, basic queueing models, and benchmark standardization. Furthermore, the course covers selected application areas and case studies, such as benchmarking of energy efficiency, virtualization, storage, microservices, cloud elasticity, performance isolation, resource demand estimation, and software and system security.

Intended learning outcomes

Students are able to design and build fair and reliable benchmarks, metrics, and measurement tools. Students can evaluate the quality of existing benchmarking approaches and benchmark results.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE, IT, ES, HCI, GE, IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Theory of Machine Learning			10-I-TML-222-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

--

Intended learning outcomes

--

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Deep Learning			10-I-DL-222-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

The lecture provides advanced knowledge of deep learning techniques such as FCN, CNN and LSTMs, practical application examples for NN architectures, e.g. in the field of image and speech processing. Current models and methods of machine learning and their technical background are presented. Building on this, models from the field of deep learning, such as CNNs, RNNs and sequence-to-sequence architectures, are discussed. The theoretical foundations of these models, such as training through backpropagation, are also discussed in detail. For all the models covered, it is shown how they are used in practice for specific problems such as image processing and text generation.

Intended learning outcomes

Students have knowledge of the possible applications and limitations of deep learning, of important architectures and how they are implemented in tools such as Tensorflow/Keras, of the ability to reprogram network structures from the literature, of data preparation and of solving concrete tasks.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Natural Language Processing			10-I-NLP-222-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Introduction to Text Mining and Natural Language Processing; Traditional computational representations of text data (bag-of-words) and text preprocessing (sentence splitting, tokenization, morphological normalization, stemming); Corpus linguistics and lexical association measures (ngram frequencies, co-occurrences, collocations and terminology extraction); Syntactic analysis: Part-of-Speech tagging and chunking (with Hidden Markov Models and Conditional Random Fields), parsing (Probabilistic Context Free Grammars and parsers); Distributional semantics and latent text representations: distributional hypothesis, Latent Semantic Analysis (LSA), word embeddings; Light introduction to (modern) deep learning-based NLP: embeddings, convolutional and recurrent networks, Transformers. NLP Applications: text classification tasks (e.g., document classification, sentiment analysis) vs. token classification tasks (e.g., information extraction - named entity recognition) vs. text generation tasks (e.g. machine translation and text summarization).

Intended learning outcomes

Students will obtain broad theoretical and practical knowledge of the typical methods and algorithms in the field of text mining and natural language processing. They will be able to solve practical problems with the obtain knowledge: analyze the text data for the task at hand, choose the appropriate representation for their texts as well as the appropriate (machine learning for NLP) model to solve the task. They will have gained rich practical experience implementing solutions for a wide range of common NLP tasks and applications.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Computer Vision			10-I-CV-222-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science IV		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

This course aims at offering a self-contained account of computer vision and its underlying concepts, including the recent use of deep learning. It starts with an overview of existing and emerging computer vision applications. It shows how image processing is entering multiple fields from our daily life. First, the light-matter interaction is considered and the image acquisition cameras and illumination sources are also discussed. The course then turns to image representation and discretization, and describes pre-processing steps (such as linear and non-linear filters) used to enhance image quality and/or detect specific features. The course will continue by analyzing procedures to extract information from multiple images, with motion and 3D shape as major examples. Finally, the recognition of objects (specific and/or class level) will be discussed and different approaches will be analyzed. A large part of the course concerns deep learning and AI-based approaches to vision tasks.

Intended learning outcomes

- Understanding of important computer vision concepts: light, matter, acquisition of images, color, texture, sampling, quantization, enhancement, feature extraction, segmentation, 3D acquisition, motion, tracking, object recognition.
- Understanding of deep learning (MLP, ConvNets, architectures) and the application to visual data.
- Deployment of vision and learning algorithms from standard libraries.
- Understanding of vision problems, and the ability to propose, debug, validate and explain solutions based on particular algorithms.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Machine Learning for Natural Language Processing			10-I=NLP-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science X		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

The lecture conveys advanced knowledge about methods in computational text processing. To this end, it presents state of the art models and techniques in the area of machine learning, as well as their technical background, and their respective applications in Natural Language Processing. As one important building block of almost all modern NLP-models, different techniques for learning representations of words, so called Word Embeddings, are presented. Starting from this we cover, among others, models from the area of Deep Learning, like CNNs, RNNs and Sequence-to-Sequence architectures. The theoretical foundations of these models, like their training with Backpropagation, are also covered in depth. For all models presented in the lecture, we show their application to problems like sentiment analysis, text generation and machine translation in practice.

Intended learning outcomes

The participants have solid knowledge on problems and methods in the area of computational text processing and are able to identify and apply suitable methods for a specific task.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,KI,HCI

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
NLP and Text Mining			10-I=STM-162-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science VI		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Foundations in the following areas: definition of NLP and text mining, properties of text, sentence boundary detection, tokenisation, collocation, N-gram models, morphology, hidden Markov models for tagging, probabilistic parsing, word sense disambiguation, term extraction methods, information extraction, sentiment analysis. The students possess theoretical and practical knowledge about typical methods and algorithms in the area of text mining and language processing mostly for English. They are able to solve problems through the methods taught. They have gained experience in the application of text mining algorithms.

Intended learning outcomes

The students possess theoretical and practical knowledge about typical methods and algorithms in the area of text mining and language processing. They are able to solve practical problems with the methods acquired in class. They have gained experience in the application of text mining algorithms.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT, IT, HCI.

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Multilingual NLP			10-I=MNLP-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Languages of the world: language families, typology, etymology. Linguistic universals: words, morphology, parts-of-speech, syntax. Alphabets (scripts), encoding, and language identification. Multilingual word representation spaces (aka cross-lingual word embeddings). Transformer architecture and Pretrained (multilingual) Language Models. Machine translation. Multilingual resources: unlabeled corpora, lexico-semantic networks and word translations, parallel corpora. Cross-lingual transfer: from word alignment and label projection, over MT-based transfer to zero-shot and few-shot transfer with multilingual Transformer-based language models. Advanced topics: curse of multilinguality, modularization and language adaptation, multilingual sentence encoders, contextual parameter generation, multi-source transfer, gradient manipulations.

Intended learning outcomes

Students will acquire theoretical and practical knowledge on modern multilingual natural language processing and also get an insight into cutting edge research in (multilingual) NLP. They will learn how to represent texts from different languages in shared representation spaces that enable semantic comparison and cross-lingual transfer for various NLP tasks. Upon successful completion of the course, the students will be well-equipped to solve practical NLP problems regardless of the language of the text data, and to determine the optimal strategy to obtain best performance for any concrete target language.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Sustainable Mobility			10-I=NAMO-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

--

Intended learning outcomes

--

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 90 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IN

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Computer Science and Ethics			10-I-IuE-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science III		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

The content of the module focuses on the connection between ethics and computer science, implications for computer science (e.g. in implementation) and also technical possibilities (e.g. in the design of software, mechanisms or algorithms, in the operation of systems or networks).

Intended learning outcomes

The aim of the module is the scientific discourse on ethical problems in computer science. After completing the module, students have a basic awareness of computer science based on hypothetical but realistic case studies on ethical conflict cases.

Courses (type, number of weekly contact hours, language — if other than German)

V/S (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) term paper (10 to 15 pages) and presentation (30 to 45 minutes) with subsequent discussion
Language of assessment: German and/or English

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Machine Learning			10-AI=ML-242-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Foundations in the following areas: Theoretical knowledge and practical experience in machine learning. Models, approaches and algorithms, and their practical implementation for the classical problems of machine learning. Supervised and unsupervised learning methods.

Intended learning outcomes

The students have theoretical and practical knowledge of typical models, methods and algorithms in the field of machine learning. They are able to solve practical problems in the field of machine learning with the help of appropriate methods. They have experience in the application or implementation of machine learning approaches.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Machine Learning for Networks 1			10-I=MLN1-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XV		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Networks matter! This holds for technical infrastructures like communication or transportation networks, for information systems and social media in the World Wide Web, but also for various social, economic and biological systems. What can we learn from data that capture the interaction topology of such complex systems? What is the role of individual nodes and how can we discover significant patterns in the structure of networks? How do these structures influence dynamical process like diffusion or the spreading of epidemics? Which are the most influential actors in a social network? And how can we analyze time series data on systems with dynamic network topologies?

Addressing those questions, the course combines a series of lectures -- which introduce fundamental concepts for the statistical modelling of complex networks -- with weekly exercises that show how we can apply them to practical network analysis tasks. Topics covered include foundations of graph theory, centrality and modularity measures, aggregate statistical characteristics of large networks, random graphs and statistical ensembles of complex networks, generating function analysis of expected graph properties, scale-free networks, stochastic dynamics in networks, spectral analysis, as well as the modelling of time-varying networks. The course material consists of annotated slides for lectures as well as a accompanying git-Repository of jupyter notebooks, which implement and validate the theoretical concepts covered in the lectures. Students can test and deepen their knowledge through weekly exercise sheets. The successful completion of the course requires to pass a final written exam.

Intended learning outcomes

The course will equip participants with statistical network analysis techniques that are needed for the data-driven modelling of complex technical, social, and biological systems. Students will understand how we can quantitatively model the topology of networked systems and how we can detect and characterize topological patterns. Participants will learn how to use analytical methods to make statements about the expected properties of very large networks that are generated based on different stochastic models. They further gain an analytical understanding of how the structure of networks shapes dynamical processes, how statistical fluctuations in degree distributions influence the robustness of systems, and how emergent network features emerge from simple random processes.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: English
creditable for bonus

Allocation of places

--

Additional information
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,IT,SE,KI,HCI,IN
Workload
150 h
Teaching cycle
Teaching cycle: every year, summer semester
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Machine Learning for Networks 2			10-I=MLN2-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XV		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Graph representations of relational data have become an important foundation to address data science and machine learning tasks across the sciences. Graph mining and learning techniques help us to detect functional modules in biological networks and communities in social networks, to find missing links in social networks, or to address node-, link-, or graph-level classification tasks. But how can we apply frequentist and Bayesian statistical learning techniques to data on complex networks? And how we can use the topology of relationships to infer similarity scores between objects that can, e.g., be used for the design of recommender systems? How can we use matrix factorization techniques to generate low-dimensional vector-space representations of nodes that retain a maximum amount of information about the topology of links? And how can we apply the latest deep learning techniques to address node-, link-, or graph-level learning tasks in data with relation structures?

Addressing these questions, this course combines a series of lectures - which introduce theoretical concepts in statistical learning, representation learning, and graph neural networks -- with practice sessions that show how we can apply them in practical graph learning tasks. The course material consists of annotated slides for lectures and a series of accompanying jupyter notebooks.

Intended learning outcomes

The course will equip students with techniques to address supervised and unsupervised learning tasks in data on complex networks. Students will learn how statistical learning and data compression techniques can be used to infer cluster pattern and how topological similarity scores can be used to address unsupervised link prediction and graph reconstruction. Participants will further study both algebraic and deep learning based methods to learn low-dimensional vector-space representations of graph-structured data, and learn how graph neural networks help us to apply deep learning to node- and graph-level learning tasks in large complex networks. Students can apply and deepen their knowledge through weekly exercise sheets. The successful completion of the course requires to pass a final written exam.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,IT,SE,KI,HCI,IN

Workload
150 h
Teaching cycle
Teaching cycle: if announced
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Statistical Network Analysis			10-I-SNA-222-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XV		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Networks matter! This holds for technical infrastructures like communication or transportation networks, for information systems and social media in the World Wide Web, but also for various social, economic and biological systems. What can we learn from data that capture the interaction topology of such complex systems? What is the role of individual nodes and how can we discover significant patterns in the structure of networks? How do these structures influence dynamical process like diffusion or the spreading of epidemics? Which are the most influential actors in a social network? And how can we analyse time series data on systems with dynamic network topologies?

Addressing those questions, the course combines a series of lectures - which introduce fundamental concepts for the statistical modelling of complex networks - with weekly exercises that show how we can apply them to practical network analysis tasks. Topics covered include foundations of graph theory, centrality and modularity measures, aggregate statistical characteristics of large networks, random graphs and statistical ensembles of complex networks, generating function analysis of expected graph properties, scale-free networks, stochastic dynamics in networks, spectral analysis, as well as the modelling of time-varying networks. The course material consists of annotated slides for lectures as well as a accompanying git-Repository of jupyter notebooks, which implement and validate the theoretical concepts covered in the lectures.

Intended learning outcomes

The course will equip participants with statistical network analysis techniques that are needed for the data-driven modelling of complex technical, social, and biological systems. Students will understand how we can quantitatively model the topology of networked systems and how we can detect and characterize topological patterns. Participants will learn how to use analytical methods to make statements about the expected properties of very large networks that are generated based on different stochastic models. They further gain an analytical understanding of how the structure of networks shapes dynamical processes, how statistical fluctuations in degree distributions influence the robustness of systems, and how emergent network features emerge from simple random processes.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload
150 h
Teaching cycle
Teaching cycle: once a year, winter semester
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Image Processing and Computational Photography			10-I=IP-222-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science IV		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

This course aims at offering a self-contained account of image processing and computational photography and its underlying concepts, including the recent use of deep learning. The topics that will be covered are:

- introduction to image processing and computational photography
- sampling and quantization
- light and color
- image acquisition
- deep learning
- generative methods
- image signal processing
- image restoration
- sensor and image quality assessment
- image compression
- applications

Intended learning outcomes

Students have fundamental knowledge of problems and techniques in the field of image processing and computational photography and are able to independently identify and apply suitable methods for concrete problems.

- Overview of the most important concepts of image formation, perception and analysis, and Computational Photography
- Gaining experience through home assignments, practical computer and programming exercises
- Providing a sound solid background knowledge for the Computer Vision courses

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Reinforcement Learning and Computational Decision Making			10-I=RLCDM-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

This course will provide the essential notions about reinforcement learning and further related approaches for computational decision-making (e.g., multi-armed bandits, recommender systems). The topics will be covered under a both theoretical and empirical lens, providing the rigorous mathematical foundations of reinforcement learning and decision-making, complementing them with concrete examples of real-world applications.

Intended learning outcomes

The students will gain fundamental knowledge of Reinforcement Learning spanning from classical methods to modern algorithms based on deep learning techniques, and Decision-Making approaches such as multi-armed bandits and recommender systems. Students will know about the theoretical treatment of the methods explained in the course, and will have a deep understanding of the importance of Reinforcement Learning and Decision-Making in solving real-world problems. They will be able to design, implement, and conduct Reinforcement Learning experiments for solving problems from simulated basic tasks to advanced real-world applications, e.g., games, autonomous driving, finance, robotics.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Music Information Retrieval			10-I=MIR-252-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

This lecture introduces the research field of Music Information Retrieval (MIR), focussing on the following topics: Music representations (graphical, symbolic, audio), basic music theory concepts, audio signal processing (esp. time-frequency transformations, variants of the Fourier transform), selected machine learning techniques, overview and in-depth study of individual MIR tasks (e.g., harmony analysis/chord recognition, beat tracking/tempo, structure analysis, genre/style classification), data preparation/annotation and corpus analysis for digital humanities/musicology

Intended learning outcomes

The students have a fundamental understanding of music representations and audio data as well as theoretical and practical knowledge in the field of audio signal processing and specialized machine learning techniques. They have gained experience with typical MIR tasks and are able to understand, develop, and apply MIR algorithms.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) oral examination of one candidate each (approx. 20 minutes) or
c) oral examination in groups of up to 3 candidates (approx. 15 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): GE

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Operations Research			10-I=OR-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Production plans, railway timetables, the assignment of radio frequencies, planning of delivery tours, or the construction of an 'optimal' university timetable: these problems – and many more – can be modeled as (mixed-) integer linear optimization problems and solved with integer programming methods.
This course teaches integer programming methods like branch-and-bound, cutting plane, and decomposition methods. Furthermore, we practice our modeling skills by studying a variety of application examples.

Intended learning outcomes

After completing the course
- The students are able to model optimization problems as mathematical program (in particular: mixed-integer linear programs).
- The students are able to apply integer programming methods and understand how and why these work.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IN

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Information Retrieval			10-I=IR-242-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

IR models (e. g. Boolean and vector space model, evaluation), processing of text (tokenising, text properties), data structures (e. g. inverted index), query elements (e. g. query operations, relevance feedback, query languages and paradigms, structured queries), search engine (e. g. architecture, crawling, interfaces, link analysis), methods to support IR (e. g. recommendation systems, text clustering and classification, information extraction).

Intended learning outcomes

Students acquire theoretical and practical knowledge in the field of information retrieval and the technical know-how to build a search engine.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits):
IT, KI, HCI, GE

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Computational Complexity II			10-I=KT2-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Properties of NP-complete sets, autoreducibility, interactive proof systems, polynomial time hierarchy, complexity of probabilistic algorithms.

Intended learning outcomes

The students possess a fundamental and applicable knowledge in the areas of properties of NP-complete sets, autoreducibility, interactive proof systems, polynomial time hierarchies, complexity of probabilistic algorithms.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
Assessment offered: In the semester in which the course is offered and in the subsequent semester
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT, SE, IT, ES

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Performance Evaluation of Distributed Systems			10-I=LVS-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science III		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

The performance evaluation of distributed systems is illustrated and practically performed on a contemporary example, e.g., the Internet of Things (IoT). The following topics will be conveyed:
Traffic theoretic models, fundamental concepts of theory of probability, transformation techniques, stochastic processes, methods for performance analysis of technical systems, queuing and traffic theory, discrete-time and continuous Markov chains, analysis of Markov and non-Markov systems, practical examples for performance evaluation of computer systems and networks: service quality and other characteristics.

Intended learning outcomes

The students possess the methodic knowledge and the practical skills necessary to model technical systems by means of the theory of probability and mathematical statistics.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,IT,GE,IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Introduction in AI			10-AI=IAI-242-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Essential concepts and algorithms of artificial intelligence. Theoretical or practical competences are taught, ranging from classical simple heuristic methods to more complex probabilistic models of artificial intelligence.

Intended learning outcomes

The students have theoretical and practical knowledge in the field of artificial intelligence. They are able to identify and apply appropriate methods to solve problems in the field of AI.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Mathematical Logic			10-I=ML-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Propositional logic, first-order predicate logic, proof and deduction, Gödel's completeness theorem, Tarski theorem, Gödel's incompleteness theorem, undecidability and nonaxiomatisability of elemental arithmetic.

Intended learning outcomes

The students possess a fundamental and applicable knowledge in the areas of propositional logic, first-order predicate logic, proof and deduction, Gödel's completeness theorem, Tarski theorem, Gödel's incompleteness theorem, undecidability and nonaxiomatisability of elemental arithmetic.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
Assessment offered: In the semester in which the course is offered and in the subsequent semester
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,SE,KI,ES

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Medical Informatics			10-I=MI-212-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Electronic patient folder, coding of medical data, hospital information systems, operation of computers in infirmary and functional units, medical decision making and assistance systems, statistics and data mining in medical research, case-based training systems in medical training.

Intended learning outcomes

The students possess theoretical and practical knowledge about the application of computer science methods in medicine.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE, IT, KI, HCI, GE

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Professional Project Management			10-I=PM-252-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science III		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	We recommend completing module 10-I=PRJAK in parallel.	

Contents

Project goals, project assignment, project success criteria, business plan, environment analysis and stakeholder management, initialisation, definition, planning, execution/control, finishing of projects, reporting, project communication and marketing, project organisation, team building and development, opportunity and risk management; conflict and crisis management, change and claim management; contract and procurement management, quality management, work techniques, methods and tools; leadership and social skills in project management, program management, multiproject management, project portfolio management, PMOs; peculiarities of software projects; agile project management/SCRUM, combination of classic and agile methods.

Intended learning outcomes

The students possess practically relevant knowledge about the topics of production management and/or professional project management. They are familiar with the critical success criteria and are able to initiate, define, plan, control and review projects.

Courses (type, number of weekly contact hours, language — if other than German)

V (4)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE, IT, KI, ES, LR, HCI, GE, IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Robotics 1			10-LURI=RO1-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XVII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

History, applications and properties of robots, direct kinematics of manipulators: coordinate systems, rotations, homogenous coordinates, axis coordinates, arm equation. Inverse kinematics: solution properties, end effector configuration, numerical and analytical approaches, examples of different robots for analytical approaches. Workspace analysis and trajectory planning, dynamics of manipulators: Lagrange-Euler model, direct and inverse dynamics. Mobile robots: direct and inverse kinematics, propulsion system, tricycle, Ackermann steering, holonomes and non-holonome restrictions, kinematic classification of mobile robots, posture kinematic model. Movement control and path planning: roadmap methods, cell decomposition methods, potential field methods. Sensors: position sensors, speed sensors, distance sensors.

Intended learning outcomes

The students master the fundamentals of robot manipulators and vehicles and are, in particular, familiar with their kinematics and dynamics as well as the planning of paths and task execution.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): KI, ES, LR, HCI, GE

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Robotics 2			10-LURI=RO2-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XVII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Foundations of dynamic systems, controllability and observability, controller design through pole assignment: feedback and feed-forward, state observer, feedback with state observer, time discrete systems, stochastic systems: foundations of stochastics, random processes, stochastic dynamic systems, Kalman filter: derivation, initialising, application examples, problems of Kalman filters, extended Kalman filter.

Intended learning outcomes

The students master all fundamentals that are necessary to understand Kalman filters and their use in applications of robotics. The students possess a knowledge of advanced controller and observer methods and recognise the connections between the dual pairs controllability - observability as well as controller design and observer design. They also recognise the relationship between the Kalman filter as a state estimator and an observer.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2) + P (1)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): KI, ES, LR, HCI, GE

Workload

300 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Discrete Event Simulation			10-I=ST-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science III		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

The simulation of communication systems is illustrated and practically performed on contemporary examples, e.g., popular Internet services or the Internet of Things (IoT). The following topics will be conveyed:
Introduction to simulation techniques, discrete-event simulation and process-oriented simulation, generating random numbers and random variables, statistical analysis of simulation results, evaluation of measured data, designing and evaluating simulation experiments, special random processes, possibilities and limitations of modelling and simulation, advanced concepts and techniques, practical execution of simulation projects.

Intended learning outcomes

The students possess the methodic knowledge and the practical skills necessary for the stochastic simulation of (technical) systems, the evaluation of results and the correct assessment of the possibilities and limits of simulation methods.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IT,KI,ES,GE,IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Energy Informatics 1			10-I=EI1-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science XI		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Fundamentals of physical units; Fundamentals of the structure of energy systems and their components; Modeling of energy systems; Energy markets; Components of intelligent power grids and smart grids; Demand side management and flexible consumers; Virtual power plants; Sector coupling; Current research topics

Intended learning outcomes

Students understand the basic structure of energy systems and their components (wind and PV plants, power plants, electricity grids, consumers, storage technologies and markets). They can use modeling, simulation and optimization methods for the analysis of sustainable energy systems and are able to model energy systems with modern software tools. In addition, they are able to interpret and evaluate concepts for intelligent power grids (smart grids) as well as for the integration of renewable energies, energy storage, electric vehicles, heat pumps and other flexible loads. They will also be able to identify opportunities, risks and challenges of the energy transition as well as the role of informatics in this context.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IN

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Software Architecture			10-I=SAR-161-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science II		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Introduction to software architecture, architectural styles and patterns, software metrics, evaluation of architectural styles, software components, interface models and design guidelines, design-by-contract, component-based software engineering, service-oriented architectures, microservice architectures, scalability of databases, cloud-native and serverless computing, continuous integration, continuous delivery, continuous deployment, model-driven architecture

Intended learning outcomes

The students possess a fundamental and applicable knowledge about advanced topics in software engineering with a focus on modern software architectures and fundamental approaches to model-driven software engineering.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE,IT,ES

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Spacecraft System Analysis			10-LURI=SSA-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science VIII		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Introduction: history of space flight, system design of spacecraft. Space dynamics: two-body dynamics, Kepler orbits, disturbance forces, transfer orbits. Mission analysis: earth and sun-synchronous orbits, shadows, solar angle of incidence. Thermal control of satellites: thermal analysis, thermal design and technologies, verification of thermal designs. Telecommunication: ground contact analysis, data transmission, satellite monitoring (telemetry, telecommando). Structure and mechanisms. Energy systems: primary, secondary, management, power generation: solar cells. On-board data processing. Propulsion systems. Tests (mechanical, electrical). Operation of spacecraft. Ground segment.

Intended learning outcomes

The students master system aspects of the layouting of technical systems. Using the example of spacecraft, major subsystems and their integration into a working whole are being analysed.

Courses (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)
Module taught in: English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): ES, LR

Workload

300 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Visualization of Graphs			10-I=VG-161-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science I		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

This course covers the most important algorithms to draw graphs. Methods from the course *Algorithmische Graphentheorie* (*Algorithmic Graph Theory*) such as divide and conquer, flow networks, integer programming and the planar separator theorem will be used. We will become familiar with measures of quality of a graph drawing as well as algorithms to optimise these measures.

Intended learning outcomes

The participants get an overview of graph visualisation and become familiar with typical tools. They consolidate their knowledge about the modelling and solving of problems with the help of graphs and graph algorithms.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT,IT,HCI,GE

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Introduction to IT Security			10-I=SEC-252-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science II		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

The course provides a broad sweep through concepts and technologies related to IT security:

- Theoretical aspects: information-theoretic security, computational security, introduction to cryptography (historical and modern ciphers, hash functions, pseudo-random generators, message authentication codes, public key cryptography)
- Network security: protocol security, security of TCP/IP, public key infrastructure, user authentication
- Software security: Software vulnerabilities, common programming errors and exploitation techniques, reverse engineering and obfuscation, malware and anti-malware
- Platform security: access control models, security policies, operating system security, virtualization, security mechanisms with support in hardware

Intended learning outcomes

Students will be introduced to the main concepts and abstractions of IT security. They learn how to model threats and analyze security of a system critically from the attacker view point. After visiting the lecture students are going to understand the purpose and function of several security technologies, as well as their limitations. The exercises provide some hands-on experience of security flows in software.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SEC, IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Security of Software Systems			10-I=SSS-232-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science II		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

The lecture provides an overview of common software vulnerabilities, state-of-the-art attack techniques on modern computer systems, as well as the measures implemented to protect against these attacks. In the course, the following topics are discussed:

- x86-64 instruction set architecture and assembly language
- Runtime attacks (code injection, code reuse, defenses)
- Web security
- Blockchains and smart contracts
- Side-channel attacks
- Hardware security

Intended learning outcomes

Students gain a deep understanding of software security, from hardware and low-level attacks to modern concepts such as blockchains. The lecture prepares for research in the area of security and privacy, while the exercises allow students to gain hands-on experience with attacks and analysis of systems from an attacker's perspective.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes)
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE,KI,LR, HCI, ES, SEC,IN

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Algorithms			10-I=AKA-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in algorithmics.

Intended learning outcomes

The students understand the basic approach of algorithmic computer science. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits):
AT

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Theory			10-I=AKT-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in theory.

Intended learning outcomes

The students understand the basic approach of theoretical computer science. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits):
AT

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Software Engineering			10-I=AKSE-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in software engineering.

Intended learning outcomes

The students possess an advanced knowledge about selected aspects of software engineering.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE.

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Games Engineering			10-I=AGE-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected chapters of Games Engineering.

Intended learning outcomes

The students understand the basic approach of games engineering. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): GE.

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in IT Security			10-I=AKITS-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in IT security.

Intended learning outcomes

The students possess an advanced knowledge in the area of IT security. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE, KI, LR, HCI, ES, SEC

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Internet Technologies			10-I=AKIT-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Students understand basic concepts of communication networks and systems, in particular Internet technology, mobile communication, network planning and network management. They will be able to classify the principles of modern network architectures and protocols and transfer their application to current and future developments.

Intended learning outcomes

The students have a knowledge of advanced and current topics in the management and design of modern wired and wireless communication systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IT.

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Intelligent Systems			10-I=AKIS-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in intelligent systems.

Intended learning outcomes

The students possess an advanced knowledge in the area of intelligent systems. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): KI

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Embedded Systems			10-I=AKES-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in embedded systems.

Intended learning outcomes

The students possess specialised knowledge in the area of embedded systems. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): ES.

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Aerospace Engineering			10-I=AKLR-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in aerospace engineering, for example: satellite communication, rocket science, propulsion systems, sensors and actuators for orientation control, perturbation of orbits, interplanetary orbits, rendezvous and docking, design of space ships, design of planetary bases, life support systems, special aspects of operations, payloads, optical systems, RADAR, earth monitoring, thermo management, structure of space ships, special areas of navigation, space environment, environment simulation, verification and test of space faring systems, space astronomy and planet missions, space medicine and biology, material science, quality management, space law, aeroflight topics, avionics for airplanes, air traffic control, areal navigation, pilot interfaces, air traffic control, air traffic management.

Intended learning outcomes

The students possess an advanced knowledge about the respective topic of the selected area and are able to consider these foundations in their future plans of air or spaceborne systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR.

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in HCI			10-I=AKHCI-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in HCI.

Intended learning outcomes

The students understand the basic approach of human-computer interaction. They are able to understand the solutions to complex problems in this area and to transfer them to related questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü/S (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): HCI.

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Data Science			10-I=AKDS-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in data science

Intended learning outcomes

Students understand the basic approach of data science. They are able to understand how to solve complex problems in this field and transfer them to related issues.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): KI

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Autonomous Mobile Systems			10-I=AKAMS-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in autonomous mobile systems

Intended learning outcomes

Students understand the basic approach of autonomous mobile systems. They are able to understand solutions to complex problems in this field and transfer them to related issues.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR, ES, KI.

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Computer Science and Sustainability			10-I=AKNA-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in computer science and sustainability

Intended learning outcomes

The students understand the basic approach of topics in sustainability and IT. They are able to understand the solutions to complex problems in this area and to apply them to similar questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: German and/or English

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IN

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Selected Topics in Computer Science			10-I=AKII-232-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Selected topics in computer science.

Intended learning outcomes

The students are able to understand the solutions to complex problems in computer science and to transfer them to related questions.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü/S (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 60 to 120 minutes) or
b) project work (report (approx. 20 pages) with presentation (30 to 45 minutes) and subsequent discussion on the topic) or
c) oral examination of one candidate each (approx. 20 minutes) or
d) oral examination in groups of up to 3 candidates (approx. 15 minutes per candidate)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: if announced

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Multimodal User Interfaces			10-HCI=MMUI-161-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science IX		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

The multimodal interaction paradigm simultaneously uses various modalities like speech, gesture, touch, or gaze, to communicate with computers and machines. Basically, multimodal interaction includes the analysis as well as the synthesis of multimodal utterances. This course concentrates on the analysis, i.e., the input processing. Input processing has the goal to derive meaning from signal to provide a computerized description and understanding of the input and to execute the desired interaction. In multimodal systems, this process is interleaved between various modalities and multiple interdependencies exist between simultaneous utterances necessary to take into account for a successful machine interpretation.
In this course, students will learn about the necessary steps involved in processing unimodal as well as multimodal input. The course will highlight typical stages in multimodal processing. Using speech processing as a primary example, they learn about:
1. A/D conversion
2. Segmentation
3. Syntactical analysis
4. Semantic analysis
5. Pragmatic analysis
6. Discourse analysis
A specific emphasize will be on stages like morphology and semantic analysis. Typical aspects of multimodal interdependencies, i.e., temporal and semantic interrelations are highlighted and consequences for an algorithmic processing are derived. Prominent multimodal integration (aka multimodal fusion) approaches are described, including transducers, state machines, and unification.

Intended learning outcomes

After the course, the students will be able to build their own multimodal interfaces. They will have a broad understanding of all the necessary steps involved and will know prominent algorithmic solutions for each of them. Student will learn about available tools for reoccurring tasks and their pros and cons.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

presentation of project results (approx. 40 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): HCI,GE.

Workload

150 h

Teaching cycle
Teaching cycle: every year, summer semester
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Introduction into Human-Computer Interaction			10-I-MCS-242-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science IX		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Human-Computer Interaction studies the design, evaluation, and implementation of interactive computer systems. Special focus lies on fundamental psychological and physiological properties of the human users, the technical principals and models of modern computer systems, as well as on the derived boundary conditions of designing usable and human-oriented interactions with technical systems. The topics of this course cover the human perception and cognition, the human memory and attention, the design of interactive systems, popuplar evaluation methods, principles of computer systems, input processing techniques, human interfaces and typical means of interaction, from text-based input methods over graphical user interfaces to multi-modal interfaces. Accompanying practical tasks convey to the students typical methods of requirement analysis, prototyping and evaluation.

Intended learning outcomes

After successfully completing this course, students have a fundamental understanding of human-computer interface design principles. They understand the possibilities and limitations of technology and user and the applications of modern user interfaces. They know the necessary steps of user-centric design and typical design principles.

Courses (type, number of weekly contact hours, language — if other than German)

V (3) + Ü (1)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 120 minutes) or
b) presentation (30 to 60 minutes) or
c) oral examination of one candidate each (30 to 60 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

150 h

Teaching cycle

Teaching cycle: once a year, winter semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
3D User Interfaces			10-HCI=3DUI-161-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science IX		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

This module will give students the opportunity to learn about the specificities of 3D User Interfaces (3DUI) development using Virtual, Augmented or Mixed Reality technologies. The module content will be mainly dedicated to learn and practice the skills essential to the design and implementation of high-quality 3D interaction techniques. Design guidelines as well as classical and innovative 3D Interaction techniques will be studied. In addition, the course will address novel research themes such as 3D interaction for large displays and games; and integrating 3DUIs with mobile devices, robotics, and the environment. Students will be assessed through a group practical project (team work), which will consist of a program, a presentation, a technical report (2 ages) and a video. Previous years, the assignment replicated the IEEE 3DUI Contest 2011, where teams of students competed between each other to find the best solution (see results at https://www.youtube.com/watch?v=gYs-pBW7Agc and https://www.youtube.com/watch?v=gYs-pBW7Agc)

Intended learning outcomes

After the course, the students will gain a solid background on the theory and the methods to create your own 3D spatial interfaces. They will have a broad understanding of the particular difficulties of designing and developing spatial interfaces, as well as evaluating then. Students will also learn about traditional and novel 3D input/output devices (e.g, motion tracking system and Head-mounted Display).

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

presentation of project results (approx. 30 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): HCI,GE.

Workload

150 h

Teaching cycle

Teaching cycle: every year, summer semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Machine Learning (for User Interfaces)			10-HCI=MLUI-161-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science IX		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us practical speech recognition, effective web search, self-driving cars, and a vastly improved understanding of the human genome. Machine learning is so pervasive today that you probably use it dozens of times a day without knowing it. It is one of today's prominent paradigms in HCI applicable in all areas where the understanding of user input of high variability, specifically for natural interactions using, e.g., gesture, speech, or eye-gaze, is paramount. Many researchers also think it is the best way to make progress towards human-level AI.
In this course, students will learn about the most effective machine learning techniques, and gain practice implementing them and getting them to work. Students not only learn the theoretical underpinnings of learning, but also gain the practical know-how needed to quickly and powerfully apply these techniques to new problems. Finally, they learn about some of Silicon Valley's best practices in innovation as it pertains to machine learning and AI.
This course provides a broad introduction to machine learning, data-mining, and statistical pattern recognition. Topics include: (i) Supervised learning (parametric/non-parametric algorithms, support vector machines, kernels, neural networks). (ii) Unsupervised learning (clustering, dimensionality reduction, recommender systems, deep learning). (iii) Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI). The course will also draw from numerous case studies and applications, so that you'll also learn how to apply learning algorithms to building gesture-based and multimodal interfaces, text and speech understanding (web search, anti-spam), smart robots (perception, control), computer vision, medical informatics, audio, database mining, and other areas.

Intended learning outcomes

After the course, the students will be able to solve machine learning tasks on their own using assistive technologies, e.g., like Octave. In addition, they will be able to derive main principles and apply these in own programs. Students will be able to choose the appropriate approach and tools to solve a given machine learning task in various application area, specifically in HCI.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

presentation of project results (approx. 40 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): HCI,GE.

Workload

150 h

Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Real-Time Interactive Systems			10-HCI=RIS-182-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science IX		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	graduate	--	

Contents

This course provides an introduction into the requirements, concepts, and engineering art of highly interactive human-computer systems. Such systems are typically found in perceptual computing, Virtual, Augmented, Mixed Reality, computer games, and cyber-physical systems. Lately, these systems are often termed Real-Time Interactive Systems (RIS) due to their common aspects.
The course covers theoretical models derived from the requirements of the application area as well as common hands-on and novel solutions necessary to tackle and fulfill these requirements. The first part of the course will concentrate on the conceptual principles characterizing real-time interactive systems. Questions answered are: What are the main requirements? How do we handle multiple modalities? How do we define the timeliness of RIS? Why is it important? What do we have to do to assure timeliness? The second part will introduce a conceptual model of the mission-critical aspects of time, latencies, processes, and events necessary to describe a system's behavior. The third part introduces the application state, it's requirements of distribution and coherence, and the consequences these requirements have on decoupling and software quality aspects in general. The last part introduces some potential solutions to data redundancy, distribution, synchronization, and interoperability. Along the way, typical and prominent state-of-the-art approaches to reoccurring engineering tasks are discussed. This includes pipeline systems, scene graphs, application graphs (aka field routing), event systems, entity and component models, and others. Novel concepts like actor models and ontologies will be covered as alternative solutions. The theoretical and conceptual discussions will be put into a practical context of today's commercial and research systems, e.g., X3D, instant reality, Unity3d, Unreal Engine 4, and Simulator X.

Intended learning outcomes

After the course, the students will have a solid understanding of the boundary conditions defined by both, the physiological and psychological characteristics of the human users as well as by the architectures and technological characteristics of today's computer systems. Participants will gain a solid understanding about what they can expect from today's technological solutions. They will be able to choose the appropriate approach and tools to solve a given engineering task in this application area and they will have a well-founded basis enabling them to develop alternative approaches for future real-time interactive systems.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): HCI. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

Workload
150 h
Teaching cycle
--
Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Digital media 1			10-MK-DigMed1-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science V			
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
5	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

The development of multimedia and multimodal media for the presentation of information has fundamentally transformed the way computers and media are used within few years. Since digital media is created on the computer but consumed by humans, media informatics needs to focus on technology as well as humans. The module aims to provide fundamental knowledge of digitization and coding as well as the basic functionalities of digital media types such as audio, images, 2D vector graphics and texts.

Intended learning outcomes

Students acquire a basic knowledge of human perception as well as the digitization, compression and editing of various digital media types. In the accompanying tutorials, the contents of the lecture are deepened, practiced and practically applied.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 50 minutes) or
b) oral examination of one candidate each (approx. 20 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

Instead of an exercise, a tutorial with 2 SWS can be offered.

Workload

150 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Module title			Abbreviation
Digital media 2			10-MK-DigMed2-212-m01
Module coordinator		**Module offered by**	
holder of the Chair of Computer Science V			
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
10	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

The lecture Media Informatics 2 provides a practice-oriented insight into the functioning of the Internet and the WWW, as well as the basics of developing and designing digital online media.
Additional digital media types are introduced, based on the lecture Media Informatics 1.
At the end of the module research topics in Media Informatics will be introduced and presented in an applied-practical way.

Intended learning outcomes

The students have a deeper insight into selected media types. In addition, digital media can be developed (for the WWW) using various processes. In the accompanying tutorials the contents of the lecture are deepened, practiced and applied practically.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) written examination (approx. 100 minutes) or
b) oral examination of one candidate each (approx. 30 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

--

Additional information

--

Workload

300 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 3 b)

Teaching

(10 ECTS credits)

Area 1

(10 ECTS credits)

Module title			Abbreviation
Computer Science Education 1 (incl. Practical Course in the Application of Computer Science Systems form an Educational Point of View)			10-I-DDI1-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
6	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
2 semester	undergraduate	--	

Contents

The module gives an overview of computer science didactics. It demonstrates and discusses possibilities for a practical application in the classroom.

Intended learning outcomes

Students are familiar (in particular in the area of computer science in *Sekundarstufe I*) with methods, techniques and media for teaching topics in computer science. They are able to didactically analyse and prepare practical topics. Students are familiar with both historical and current teaching approaches, typical teaching methods as well as guidelines and standards for teaching computer science. They are able to plan, organise and deliver classes.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2) + P (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 49 I Nr. 2
§ 69 I Nr. 2

Module title			Abbreviation
Computer Science Education 2			10-I-DDI2-GY-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
4	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

This course discusses different topics in computer science didactics in more detail. It demonstrates and discusses possibilities for a practical application in the classroom.

Intended learning outcomes

The students are able to plan, execute and assess projects, are familiar with important aspects of the planning and analysis of computer science classes, master fundamental teaching and learning strategies and are able to assess these.

Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
creditable for bonus

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 69 I Nr. 2 and § 69 I Nr. 1 c): Rechnerarchitektur

Freier Bereich (general as well as subject-specific electives)

(0-15 ECTS credits)

Computer Science

(ECTS credits)

(Freier Bereich (general as well as subject-specific electives) -- subject specific)

Module title			Abbreviation
Exam Tutorial for the German Staatsexamen			10-I-REP-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
4	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
2 semester	undergraduate	--	

Contents

Revision of contents of modules covering the subject as well as the subject didactics of computer science.

Intended learning outcomes

The students have refreshed their skills for the solution of the type of problems asked in the written state examination.

Courses (type, number of weekly contact hours, language — if other than German)

Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

One exercise per area covered in the state examination

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

--

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 2 f)
§ 22 II Nr. 3 b)

Module title			Abbreviation
Seminar Computer Science Education			10-I-DS-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
4	numerical grade	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Selected topics in computer science didactics.

Intended learning outcomes

The students gain initial experience in the area of independent scientific work. They are able to acquaint themselves with and structure a given topic, using selected literature, as well as to prepare a talk on the respective subject. They are also able to actively participate in a scientific discussion.

Courses (type, number of weekly contact hours, language — if other than German)

S (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written elaboration (approx. 20 pages) and presentation including discussion (approx. 45 to 60 minutes) on a topic from the field of computer science didactics
Assessment offered: Only in the semester in which the course is offered

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

Teaching cycle: usually once a year

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)

Module title			Abbreviation
Advanced Topics of Computer Science Education			10-I-DV-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
4	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Discussion of topics in teaching computer science in *Gymnasium* that takes into account different aspects, in particular subject-specific foundations, didactic analyses, the contemporary debate in computer science didactics as well as possible approaches in the classroom.

Intended learning outcomes

The students are able to discuss central topics and issues on teaching computer science in a *Gymnasium*, taking into account subject-specific, didactic and methodical aspects.

Courses (type, number of weekly contact hours, language — if other than German)

S (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

a) talk (approx. 30 minutes) or
b) practical assignment (exercise) with examination talk (approx. 15 minutes)
Assessment offered: Only in the semester in which the course is offered

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

Teaching cycle: Usually every 2 years

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 2 f)
§ 22 II Nr. 2 f), § 22 II Nr. 3 f)

Module title			Abbreviation
Robotics in Education (practical course)			10-I-DRO-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
4	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Discussion of problems in robotics in the computer science classroom that takes into account different aspects, in particular subject-specific foundations, didactic analyses, the contemporary debate in computer science didactics as well as possible approaches in the classroom.

Intended learning outcomes

The students are able to discuss central topics and questions of robotics in the computer science classroom, taking into account subject-specific, didactic and methodical aspects.

Courses (type, number of weekly contact hours, language — if other than German)

Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

practical assignment (supervision of a group of pupils) with examination talk (approx. 15 minutes)
Assessment offered: Only in the semester in which the course is offered

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

Teaching cycle: Usually every 2 years

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)

Module title			Abbreviation
Practical Course on Computer Science Education			10-I-DPR-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
4	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
1 semester	undergraduate	--	

Contents

Discussion of problems in programming in the computer science classroom that takes into account different aspects, in particular subject-specific foundations, didactic analyses, the contemporary debate in computer science didactics as well as possible approaches in the classroom.

Intended learning outcomes

The students are able to discuss central topics and questions of programming in the computer science classroom, taking into account subject-specific, didactic and methodical aspects.

Courses (type, number of weekly contact hours, language — if other than German)

Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

practical assignment with examination talk (approx. 15 minutes)
Assessment offered: Only in the semester in which the course is offered

Allocation of places

--

Additional information

--

Workload

120 h

Teaching cycle

Teaching cycle: Usually every 2 years

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)

Module title			Abbreviation
Hands-on Computer Science			10-I-DPP-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
6	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
2 semester	undergraduate	--	

Contents

Design and implementation of a school project on a topic in computer science, e. g. for project days, school term papers (*Facharbeiten*), *Pluskurse* (additional courses for the in-depth study of areas of special interest), workshops. In the theoretical phase, the students formulate the subject-specific and didactic requirements of the topic, search for a suitable topic, elaborate this topic for the project and draw up a project plan. This is done in groups with students providing each other with advice as well as challenging and reflecting on each other's work. In the practical phase, the students prepare the implementation of the project, implement the project with pupils and afterwards reflect the planning and implementation.

Intended learning outcomes

The students are able to select a topic from the area of computer science that is suitable for a school project and are able to elaborate it. They are familiar with different aspects of project planning and management and are able to critically reflect the process.

Courses (type, number of weekly contact hours, language — if other than German)

Ü (2) + S (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

practical assignment (preparing and delivering a school lab session) with examination talk (approx. 15 minutes)
Assessment offered: Only in the semester in which the course is offered

Allocation of places

--

Additional information

--

Workload

180 h

Teaching cycle

Teaching cycle: Usually every 2 years

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)

Module title			Abbreviation
Tutor activity 1			10-I-TUT1-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
2	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
1-2 semester	undergraduate	--	

Contents

Tutoring activities in the area of computer science.

Intended learning outcomes

Imparting knowledge and skills to students of computer science.

Courses (type, number of weekly contact hours, language — if other than German)

T (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Wrap-up report on tutoring activities (5 to 10 pages)

Allocation of places

--

Additional information

--

Workload

60 h

Teaching cycle

Teaching cycle: every semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)

Module title			Abbreviation
Tutor activity 2			10-I-TUT2-152-m01
Module coordinator		**Module offered by**	
Dean of Studies Informatik (Computer Science)		Institute of Computer Science	
ECTS	**Method of grading**	**Only after succ. compl. of module(s)**	
2	(not) successfully completed	--	
Duration	**Module level**	**Other prerequisites**	
1-2 semester	undergraduate	--	

Contents

Tutoring activities in the area of computer science.

Intended learning outcomes

Imparting knowledge and skills to students of computer science.

Courses (type, number of weekly contact hours, language — if other than German)

T (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Wrap-up report on tutoring activities (5 to 10 pages)

Allocation of places

--

Additional information

--

Workload

60 h

Teaching cycle

Teaching cycle: every semester

Referred to in LPO I (examination regulations for teaching-degree programmes)

§ 22 II Nr. 2 f)
§ 22 II Nr. 3 f)