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Modulbereich 1

Stammvorlesungen
Modulverantwortliche/r  Prof. Dr. Kurt Mehlhorn
Dozent/in/en  Prof. Dr. Raimund Seidel
                     Prof. Dr. Kurt Mehlhorn

Zulassungsvoraussetzungen  For graduate students: C, C++, Java

Leistungskontrollen / Prüfungen
• Regular attendance of classes and tutorials
• Passing the midterm and the final exam
• A re-exam takes place during the last two weeks before the start of lectures in the following semester.

Lehrveranstaltungen / SWS  4 h lectures
                           + 2 h tutorial
                           = 6 h (weekly)

Arbeitsaufwand  90 h of classes
                + 180 h private study
                = 270 h (= 9 ECTS)

Modulnote  Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

Sprache  English

Lernziele / Kompetenzen
The students know standard algorithms for typical problems in the area's graphs, computational geometry, strings and optimization. Furthermore, they master a number of methods and data-structures to develop efficient algorithms and analyze their running times.

Inhalt
• graph algorithms (shortest path, minimum spanning trees, maximal flows, matchings, etc.)
• computational geometry (convex hull, Delaunay triangulation, Voronoi diagram, intersection of line segments, etc.)
• strings (pattern matching, suffix trees, etc.)
• generic methods of optimization (tabu search, simulated annealing, genetic algorithms, linear programming, branch-and-bound, dynamic programming, approximation algorithms, etc.)
• data-structures (Fibonacci heaps, radix heaps, hashing, randomized search trees, segment trees, etc.)
• methods for analyzing algorithms (amortized analysis, average-case analysis, potential methods, etc.)

Literaturhinweise
Will be announced before the start of the course on the course page on the Internet.
Artificial Intelligence

<table>
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Modulverantwortliche/r  Prof. Dr. Jörg Hoffmann
Dozent/inn/en  Prof. Dr. Jörg Hoffmann

Zulassungsvoraussetzungen  Programming 1, Programming 2, Fundamentals of Data Structures and Algorithms, and Elements of Machine Learning or other courses in machine learning are recommended.

Leistungskontrollen / Prüfungen
- Regular attendance of classes and tutorials
- Solving of weekly assignments
- Passing the final written exam
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

Lehrveranstaltungen / SWS  
4 h lectures
+ 2 h tutorial
= 6 h (weekly)

Arbeitsaufwand  
90 h of classes
+ 180 h private study
= 270 h (= 9 ECTS)

Modulnote  Will be determined from the performance in exams. The exact modalities will be announced at the beginning of the module.

Sprache  English

Lernziele / Kompetenzen

Knowledge about basic methods in Artificial Intelligence

Inhalt

Search:
- Uninformed- and informed search procedures
- Monte-Carlo tree search

Planning:
- Formalism and complexity
- Critical-path heuristics
- Delete relaxation heuristics
- Abstraction heuristics

Markov decision processes:
- Discounted reward and expected cost
- Value iteration
- Informed search
- Reinforcement learning

Games:
• Adversarial search  
• Learning from self-play

Literaturhinweise

Russel & Norvig Artificial Intelligence: A Modern Approach;  
further reading will be announced before the start of the course on the course page on the Internet.
Modulverantwortliche/r  Prof. Dr. Christoph Weidenbach
Dozent/inn/en   Prof. Dr. Christoph Weidenbach

Zulassungsvoraussetzungen  *Introduction to Computational Logic*

Leistungskontrollen / Prüfungen  
- Regular attendance of classes and tutorials
- Weekly assignments
- Practical work with systems
- Passing the final and mid-term exam
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

Lehrveranstaltungen / SWS  
4 h lectures  
+ 2 h tutorial  
= 6 h (weekly)

Arbeitsaufwand  
90 h of classes  
+ 180 h private study  
= 270 h (= 9 ECTS)

Modulnote  Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

Sprache  English

Lernziele / Kompetenzen

The goal of this course is to provide familiarity with logics, calculi, implementation techniques, and systems providing automated reasoning.

Inhalt

Propositional Logic – CDCL, Superposition · Watched Literals
First-Order Logic without Equality – (Ordered) Resolution,
Equations with Variables – Completion, Termination
First-Order Logic with Equality – Superposition (SUP) · Indexing

Literaturhinweise

Will be announced before the start of the course on the course page on the Internet.
**Compiler Construction**

<table>
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**Modulverantwortliche/r**  
Prof. Dr. Sebastian Hack

**Dozent/inn/en**  
Prof. Dr. Sebastian Hack

**Zulassungsvoraussetzungen**  
For graduate students: none

**Leistungskontrollen / Prüfungen**
- Regular attendance of classes and tutorials
- Written exam at the end of the course, theoretical exercises, and compiler-laboratory project.
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

**Lehrveranstaltungen / SWS**
- 4 h lectures
- 2 h tutorial
= 6 h (weekly)

**Arbeitsaufwand**
- 90 h of classes
- 180 h private study
= 270 h (= 9 ECTS)

**Modulnote**  
Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

**Sprache**  
English

**Lernziele / Kompetenzen**

The students learn, how a source program is lexically, syntactically, and semantically analyzed, and how they are translated into semantically equivalent machine programs. They learn how to increase the efficiency by semantics-preserving transformations. They understand the automata-theoretic foundations of these tasks and learn, how to use the corresponding tools.

**Inhalt**

Lexical, syntactic, semantic analysis of source programs, code generation for abstract and real machines, efficiency-improving program transformations, foundations of program analysis.

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
Modulverantwortliche/r  Prof. Dr. Markus Bläser
Dozent/inn/en    Prof. Dr. Raimund Seidel
                 Prof. Dr. Markus Bläser
Zulassungsvoraussetzungen  undergraduate course on theory of computation (e.g. *Grundzüge der Theoretischen Informatik*) is highly recommend.

Leistungskontrollen / Prüfungen
- Regular attendance of classes and tutorials
- assignments
- exams (written or oral)

Lehrveranstaltungen / SWS
- 4 h lectures
- 2 h tutorial
  = 6 h (weekly)

Arbeitsaufwand
- 90 h of classes
- 180 h private study
  = 270 h (= 9 ECTS)

Modulnote  Will be calculated from the results in the assignments and/or exams, as announced by the Lecturer at the beginning of the course

Sprache  English

Lernziele / Kompetenzen

The aim of this lecture is to learn important concepts and methods of computational complexity theory. The student shall be enabled to understand recent topics and results in computational complexity theory.

Inhalt

Relation among resources like time, space, determinism, nondeterminism, complexity classes, reduction and completeness, circuits and nonuniform complexity classes, logarithmic space and parallel complexity classes, Immerman-Szelepcsényi theorem, polynomial time hierarchy, relativization, parity and the polynomial methods, Valiant-Vaziraní theorem, counting problems and classes, Toda’s theorem, probabilistic computations, isolation lemma and parallel algorithms for matching, circuit identity testing, graph isomorphism and interactive proofs.

Literaturhinweise

Dexter Kozen: Theory of Computation, Springer
Schöning, Pruim: Gems of Theoretical Computer Science, Springer
Modulverantwortliche/r Prof. Dr. Frank-Olaf Schreyer
Dozent/inn/en Prof. Dr. Frank-Olaf Schreyer
Zulassungsvoraussetzungen For graduate students: none
Leistungskontrollen / Prüfungen
• Regular attendance of classes and tutorials
• Solving the exercises, passing the midterm and the final exam.
Lehrveranstaltungen / SWS
4 h lectures
+ 2 h tutorial
= 6 h (weekly)
Arbeitsaufwand
90 h of classes
+ 180 h private study
= 270 h (= 9 ECTS)
Modulnote Will be determined from performance in exams, exercises and practical tasks. The
exact modalities will be announced at the beginning of the module.
Sprache English

Lernziele / Kompetenzen

Solving problems occurring in computer algebra praxis
The theory behind algorithms

Inhalt

Arithmetic and algebraic systems of equations in geometry, engineering and natural sciences
• integer and modular arithmetics, prime number tests
• polynomial arithmetics and factorization
• fast Fourier-transformation, modular algorithms
• resultants, Gröbnerbasen
• homotopy methods for numerical solving
• real solutions, Sturm chains and other rules for algebraic signs Arithmetic and algebraic systems of equations in geometry, engineering and natural sciences
• integer and modular arithmetics, prime number tests
• polynomial arithmetics and factorization
• fast Fourier-transformation, modular algorithms
• resultants, Gröbnerbasen
• homotopy methods for numerical solving
• real solutions, Sturm chains and other rules for algebraic signs

Literaturhinweise

Will be announced before the start of the course on the course page on the Internet.
Lernziele / Kompetenzen

This course provides the theoretical and practical foundation for computer graphics. It gives a wide overview of topics, techniques, and approaches used in various aspects of computer graphics but has some focus on image synthesis or rendering. The first part of the course uses ray tracing as a driving application to discuss core topics of computer graphics, from vector algebra all the way to sampling theory, the human visual system, sampling theory, and spline curves and surfaces. A second part then uses rasterization approach as a driving example, introducing the camera transformation, clipping, the OpenGL API and shading language, plus advanced techniques.

As part of the practical exercises the students incrementally build their own ray tracing system. Once the basics have been covered, the students participate in a rendering competition. Here they can implement their favorite advanced algorithm and are asked to generate a high-quality rendered image that shows their techniques in action.

Inhalt

- Introduction
- Overview of Ray Tracing and Intersection Methods
- Spatial Index Structures
- Vector Algebra, Homogeneous Coordinates, and Transformations
- Light Transport Theory, Rendering Equation
- BRDF, Materials Models, and Shading
- Texturing Methods
- Spectral Analysis, Sampling Theory
- Filtering and Anti-Aliasing Methods
• Recursive Ray Tracing & Distribution Ray-Tracing
• Human Visual System & Color Models
• Spline Curves and Surfaces
• Camera Transformations & Clipping
• Rasterization Pipeline
• OpenGL API & GLSL Shading
• Volume Rendering (opt.)

**Literaturhinweise**

Will be announced in the lecture.
Cryptography

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**Modulverantwortliche/r** Dr. Nico Döttling

**Dozent/inn/en**
- Prof. Dr. Cas Cremers
- Dr. Nico Döttling
- Dr. Antoine Joux
- Dr. Lucjan Hanzlik
- Dr. Julian Loss

**Zulassungsvoraussetzungen** For graduate students: Basic knowledge in theoretical computer science required, background knowledge in number theory and complexity theory helpful

**Leistungskontrollen / Prüfungen**
- Oral / written exam (depending on the number of students)
- A re-exam is normally provided (as written or oral examination).

**Lehrveranstaltungen / SWS**
- 4 h lectures
- + 2 h tutorial
- = 6 h (weekly)

**Arbeitsaufwand**
- 90 h of classes
- + 180 h private study
- = 270 h (= 9 ECTS)

**Modulnote** Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

**Sprache** English

**Lernziele / Kompetenzen**

The students will acquire a comprehensive knowledge of the basic concepts of cryptography and formal definitions. They will be able to prove the security of basic techniques.

**Inhalt**

- Symmetric and asymmetric encryption
- Digital signatures and message authentication codes
- Information theoretic and complexity theoretic definitions of security, cryptographic reduction proofs
- Cryptographic models, e.g. random oracle model
- Cryptographic primitives, e.g. trapdoor-one-way functions, pseudo random generators, etc.
- Cryptography in practice (standards, products)
- Selected topics from current research

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
**Modulverantwortliche/r** Prof. Dr. Jens Dittrich

**Dozent/inn/en** Prof. Dr. Jens Dittrich

**Zulassungsvoraussetzungen** especially Saarland University CS department’s undergraduate lecture *Big Data Engineering* (former *Informationssysteme*), *Programmierung 1 and 2, Algorithmen und Datenstrukturen* as well as *Nebenläufige Programmierung*

For graduate students:

- motivation for databases and database management systems;
- the relational data model;
- relational query languages, particularly relational algebra and SQL;
- solid programming skills in Java and/or C++
- undergrad courses in algorithms and data structures, concurrent programming

**Leistungskontrollen / Prüfungen** • Passing a two-hour written exam at the end of the semester
• Successful demonstration of programming project (teams of up to three students are allowed); the project may be integrated to be part of the weekly assignments

Grades are based on written exam; 50% in weekly assignments (in paper and additionally paper or electronic quizzes) must be passed to participate in the final and repetition exams.

A repetition exam takes place during the last two weeks before the start of lectures in the following semester.

**Lehrveranstaltungen / SWS**

- 4 h lectures
- + 2 h tutorial
= 6 h (weekly)

This class may be run as a flipped classroom, i.e. 2 hours of lectures may be replaced by self-study of videos/papers; the other 2 hours may be used to run a group exercise supervised by the professor called “the LAB”

**Arbeitsaufwand**

- 90 h of classes
- + 180 h private study
= 270 h (= 9 ECTS)

**Modulnote** Will be determined based on project, midterm and best of endterm and reexam.

**Sprache** English

**Lernziele / Kompetenzen**

Database systems are the backbone of most modern information systems and a core technology without which today’s economy – as well as many other aspects of our lives – would be impossible in their present forms. The course teaches the architectural and algorithmic foundations of modern database management systems (DBMS), focussing on database systems internals rather than applications. Emphasis is made on robust and time-tested techniques that have led databases to be considered a mature technology and one of the greatest success stories in computer science. At the same time, opportunities for exciting research in this field will be pointed out.

In the exercise part of the course, important components of a DBMS will be treated and where possible implemented and their performance evaluated. The goal this is to work with the techniques introduced in the lecture and to understand them and their practical implications to a depth that would not be attainable by purely theoretical study.
Inhalt

The course "Database Systems" will introduce students to the internal workings of a DBMS, in particular:

- storage media (disk, flash, main memory, caches, and any other future storage medium)
- data managing architectures (DBMS, streams, file systems, clouds, appliances)
- storage management (DB-file systems, raw devices, write-strategies, differential files, buffer management)
- data layouts (horizontal and vertical partitioning, columns, hybrid mappings, compression, defragmentation)
- indexing (one- and multidimensional, tree-structured, hash-, partition-based, bulk-loading and external sorting, differential indexing, read- and write-optimized indexing, data warehouse indexing, main-memory indexes, sparse and dense, direct and indirect, clustered and unclustered, main memory versus disk and/or flash-based)
- processing models (operator model, pipeline models, push and pull, block-based iteration, vectorization, query compilation)
- processing implementations (join algorithms for relational data, grouping and early aggregation, filtering)
- query processing (scanning, plan computation, SIMD)
- query optimization (query rewrite, cost models, cost-based optimization, join order, join graph, plan enumeration)
- data recovery (single versus multiple instance, logging, ARIES)
- parallelization of data and queries (horizontal and vertical partitioning, shared-nothing, replication, distributed query processing, NoSQL, MapReduce, Hadoop and/or similar and/or future systems)
- read-optimized system concepts (search engines, data warehouses, OLAP)
- write-optimized system concepts (OLTP, streaming data)
- management of geographical data (GIS, google maps and similar tools)
- main-memory techniques

Literaturhinweise

Will be announced before the start of the course on the course page on the Internet.
Digital Signal Transmission and Signal Processing

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**Modulverantwortliche/r**  Prof. Dr.-Ing. Thorsten Herfet

**Dozent/inn/en**  Prof. Dr.-Ing. Thorsten Herfet

**Zulassungsvoraussetzungen**  The lecture requires a solid foundation of mathematics (differential and integral calculus) and probability theory. The course will, however, refresh those areas indispensably necessary for telecommunications and potential intensification courses and by this open this potential field of intensification to everyone of you.

**Leistungskontrollen / Prüfungen**  Regular attendance of classes and tutorials
Passing the final exam in the 2nd week after the end of courses.
Eligibility: Weekly exercises / task sheets, grouped into two blocks corresponding to first and second half of the lecture. Students must provide min. 50% grade in each of the two blocks to be eligible for the exam.

**Lehrveranstaltungen / SWS**  4 h lectures + 2 h tutorial = 6 h (weekly)

**Arbeitsaufwand**  90 h of classes + 180 h private study = 270 h (= 9 ECTS)

**Modulnote**  Final exam mark

**Sprache**  English

**Lernziele / Kompetenzen**
Digital Signal Transmission and Signal Processing refreshes the foundation laid in "Signals and Systems" [Modulkennung]. Including, however, the respective basics so that the various facets of the introductory study period (Bachelor in Computer Science, Vordiplom Computer- und Kommunikationstechnik, Elektrotechnik or Mechatronik) and the potential main study period (Master in Computer Science, Diplom-Ingenieur Computer- und Kommunikationstechnik or Mechatronik) will be paid respect to.

**Inhalt**
As the basic principle, the course will give an introduction into the various building blocks that modern telecommunication systems do incorporate. Sources, sinks, source and channel coding, modulation and multiplexing are the major keywords, but we will also deal with dedicated pieces like A/D- and D/A-converters and quantizers in a little bit more depth.

The course will refresh the basic transformations (Fourier, Laplace) that give access to system analysis in the frequency domain, it will introduce derived transformations (z, Hilbert) for the analysis of discrete systems and modulation schemes and it will briefly introduce algebra on finite fields to systematically deal with error correction schemes that play an important role in modern communication systems.

**Literaturhinweise**
Will be announced before the start of the course on the course page on the Internet.
Weitere Informationen

This module was formerly also known as *Telecommunications I*. 
Modulverantwortliche/r Prof. Peter Druschel, Ph.D.

Dozent/inn/en Prof. Peter Druschel, Ph.D.
Allen Clement, Ph.D

Zulassungsvoraussetzungen Operating Systems or Concurrent Programming

Leistungskontrollen / Prüfungen
• Regular attendance at classes and tutorials.
• Successful completion of a course project in teams of 2 students. (Project assignments due approximately every 2 weeks.)
• Passing grade on 2 out of 3 written exams: midterm, final exam, and a re-exam that takes place during the last two weeks before the start of lectures in the following semester.
• Final course grade: 50% project, 50% best 2 out of 3 exams.

Lehrveranstaltungen / SWS 4 h lectures
+ 2 h tutorial
= 6 h (weekly)

Arbeitsaufwand 90 h of classes
+ 180 h private study
= 270 h (= 9 ECTS)

Modulnote Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

Sprache English

Lernziele / Kompetenzen
Introduction to the principles, design, and implementation of distributed systems.

Inhalt
• Communication: Remote procedure call, distributed objects, event notification, Inhalt dissemination, group communication, epidemic protocols.
• Distributed storage systems: Caching, logging, recovery, leases.
• Naming. Scalable name resolution.
• Synchronization: Clock synchronization, logical clocks, vector clocks, distributed snapshots.
• Fault tolerance: Replication protocols, consistency models, consistency versus availability trade-offs, state machine replication, consensus, Paxos, PBFT.
• Peer-to-peer systems: consistent hashing, self-organization, incentives, distributed hash tables, Inhalt distribution networks.
• Data centers. Architecture and infrastructure, distributed programming, energy efficiency.

Literaturhinweise
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**Modulverantwortliche/r**  Prof. Bernd Finkbeiner, Ph.D

**Dozent/inn/en**  Prof. Bernd Finkbeiner, Ph.D
Prof. Dr. Martina Maggio

**Zulassungsvoraussetzungen**  keine

**Leistungskontrollen / Prüfungen**
- Written exam at the end of the course.
- Demonstration of the implemented system.
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

**Lehrveranstaltungen / SWS**

| 4 h lectures + 2 h tutorial | 6 h (weekly) |

The course is accompanied by a laboratory project, in which a non-trivial embedded system has to be realized.

**Arbeitsaufwand**

| 90 h of classes + 180 h private study | 270 h (= 9 ECTS) |

**Modulnote**  Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

**Sprache**  English

**Lernziele / Kompetenzen**

The students should learn methods for the design, the implementation, and the validation of safety-critical embedded systems.

**Inhalt**

Embedded Computer Systems are components of a technical system, e.g. an airplane, a car, a household machine, a production facility. They control some part of this system, often called the plant, e.g. the airbag controller in a car controls one or several airbags. Controlling means obtaining sensor values and computing values of actuator signals and sending them.

Most software taught in programming courses is transformational, i.e. it is started on some input, computes the corresponding output and terminates. Embedded software is reactive, i.e. it is continuously active waiting for signals from the plant and issuing signals to the plant.

Many embedded systems control safety-critical systems, i.e. malfunctioning of the system will in general cause severe damage. In addition, many have to satisfy real-time requirements, i.e. their reactions to input have to be produced within fixed deadlines.

According to recent statistics, more than 99% of all processors are embedded. Processors in the ubiquitous PC are a negligible minority. Embedded systems have a great economical impact as most innovations in domains like avionics, automotive are connected to advances in computer control. On the other hand, failures in the design of such systems may have disastrous consequences for the functioning of the overall system. Therefore, formal specification techniques and automatic synthesis of software are used more than in other domains.

The course will cover most aspects of the design and implementation of embedded systems, e.g. specification mechanisms, embedded hardware, operating systems, scheduling, validation methods.
Literaturhinweise

Will be announced before the start of the course on the course page on the Internet.
Geometric Modelling

Modulverantwortliche/r  Prof. Dr. Hans-Peter Seidel
Dozent/inn/en  Prof. Dr. Hans-Peter Seidel
Dr. Rhaleb Zayer

Zulassungsvoraussetzungen  calculus and basic programming skills

Leistungskontrollen / Prüfungen
- Regular attendance and participation.
- Weekly Assignments (10% bonus towards the course grade; bonus points can only improve the grade; they do not affect passing)
- Passing the written exams (mid-term and final exam).
- The mid-term and the final exam count for 50% each, but 10% bonus from assignments will be added.
- A re-exam takes place at the end of the semester break or early in the next semester.

Lehrveranstaltungen / SWS
- 4 h lectures
- 2 h tutorial
- 6 h (weekly)

Practical assignments in groups of 3 students (practice)
Tutorials consists of a mix of theoretical + practical assignments.

Arbeitsaufwand
- 90 h of classes
- 180 h private study
- 270 h (= 9 ECTS)

Modulnote  Will be based on the performance in exams, exercises and practical tasks. The detailed terms will be announced by the module coordinator.

Sprache  English

Lernziele / Kompetenzen
Gaining knowledge of the theoretical aspect of geometric modelling problems, and the practical solutions used for modelling and manipulating curves and surfaces on a computer. From a broader perspective: Learning how to represent and interact with geometric models in a discretized, digital form (geometric representations by functions and samples; design of linear function spaces; finding “good” functions with respect to a geometric modelling task in such spaces).

Inhalt
- Differential geometry Fundamentals
- Interpolation and Approximation
- Polynomial Curves
- Bezier and Rational Bezier Curves
- B-splines, NURBS
- Spline Surfaces
- Subdivision and Multiresolution Modelling
- Mesh processing
- Approximation of differential operators
- Shape Analysis and Geometry Processing
Literaturhinweise

Will be announced before the term begins on the lecture website.
Human Computer Interaction

<table>
<thead>
<tr>
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**Modulverantwortliche/r** Prof. Dr. Jürgen Steimle  
**Dozent/inn/en** Prof. Dr. Jürgen Steimle

**Zulassungsvoraussetzungen** undergraduate students: *Programmierung 1* and *2*  
graduate students: none

**Leistungskontrollen / Prüfungen**  
Regular attendance of classes and tutorials  
Successful completion of exercises and course project  
Final exam  
A re-exam takes place (as written or oral examination).

**Lehrveranstaltungen / SWS**  
4 h lectures  
+ 2 h tutorial  
= 6 h (weekly)

**Arbeitsaufwand**  
90 h of classes  
+ 180 h private study  
= 270 h (= 9 ECTS)

**Modulnote** Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

**Sprache** English

**Lernziele / Kompetenzen**

This course teaches the theoretical and practical foundations for human computer interaction. It covers a wide overview of topics, techniques and approaches used for the design and evaluation of modern user interfaces.

The course covers the principles that underlie successful user interfaces, provides an overview of input and output devices and user interface types, and familiarizes students with the methods for designing and evaluating user interfaces. Students learn to critically assess user interfaces, to design user interfaces themselves, and to evaluate them in empirical studies.

**Inhalt**

- Fundamentals of human-computer interaction  
- User interface paradigms, input and output devices  
- Desktop & graphical user interfaces  
- Mobile user interfaces  
- Natural user interfaces  
- User-centered interaction design  
- Design principles and guidelines  
- Prototyping

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
**Modulverantwortliche/r** Prof. Dr. Joachim Weickert

**Dozent/innen** Prof. Dr. Joachim Weickert

**Zulassungsvoraussetzungen** Undergraduate mathematics (e.g. Mathematik für Informatiker I-III) and elementary programming knowledge in C

**Leistungskontrollen / Prüfungen**
- For the homework assignments one can obtain up to 24 points per week. Actively participating in the classroom assignments gives 12 more points per week, regardless of the correctness of the solutions. To qualify for both exams one needs 2/3 of all possible points.
- Passing the final exam or the re-exam.
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

**Lehrveranstaltungen / SWS**
- 4 h lectures
- + 2 h tutorial
- = 6 h (weekly)

**Arbeitsaufwand**
- 90 h of classes
- + 180 h private study
- = 270 h (= 9 ECTS)

**Modulnote** Will be determined from the performance in the exam or the re-exam. The better grade counts.

**Sprache** English

**Lernziele / Kompetenzen**

Broad introduction to mathematical methods in image processing and computer vision. The lecture qualifies students for a bachelor thesis in this field. Together with the completion of advanced or specialised lectures (9 credits at least) it is the basis for a master thesis in this field.

**Inhalt**

Inhalt

1. Basics
   1.1 Image Types and Discretisation
   1.2 Degradations in Digital Images
2. Colour Perception and Colour Spaces
3. Image Transformations
   3.1 Continuous Fourier Transform
   3.2 Discrete Fourier Transform
   3.3 Image Pyramids
   3.4 Wavelet Transform
4. Image Compression
5. Image Interpolation
6. Image Enhancement
   6.1 Point Operations
6.2 Linear Filtering and Feature Detection
6.3 Morphology and Median Filters
6.3 Wavelet Shrinkage, Bilateral Filters, NL Means
6.5 Diffusion Filtering
6.6 Variational Methods
6.7 Deconvolution Methods
7. Texture Analysis
8. Segmentation
   8.1 Classical Methods
   8.2 Variational Methods
9. Image Sequence Analysis
   9.1 Local Methods
   9.2 Variational Methods
10. 3-D Reconstruction
   10.1 Camera Geometry
   10.2 Stereo
   10.3 Shape-from-Shading
11. Object Recognition
   11.1 Hough Transform
   11.2 Invariants
   11.3 Eigenspace Methods

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
### Modulverantwortliche/r
Prof. Dr. Gert Smolka

### Dozent/inn/en
Prof. Dr. Gert Smolka

### Zulassungsvoraussetzungen
keine

### Leistungskontrollen / Prüfungen
- Regular attendance of classes and tutorials.
- Passing the midterm and the final exam.

### Lehrveranstaltungen / SWS
- 4 h lectures
- 2 h tutorial
- = 6 h (weekly)

### Arbeitsaufwand
- 90 h of classes
- + 180 h private study
- = 270 h (= 9 ECTS)

### Modulnote
Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

### Sprache
English

### Lernziele / Kompetenzen
- structure of logic languages based on type theory
- distinction notation / syntax / semantics
- structure and formal representation of mathematical statements
- structure and formal representation of proofs (equational and natural deduction)
- solving Boolean equations
- proving formulas with quantifiers
- implementing syntax and deduction

### Inhalt

**Type Theory:**
- functional representation of mathematical statements
- simply typed lambda calculus, De Bruijn representation and substitution, normalization, elimination of lambdas
- Interpretations and semantic consequence
- Equational deduction, soundness and completeness
- Propositional Logic
- Boolean Axioms, completeness for 2-valued interpretation
- resolution of Boolean equations, canonical forms based on decision trees and resolution

**Predicate Logic (higher-order):**
- quantifier axioms
- natural deduction
- prenex and Skolem forms

### Literaturhinweise
Will be announced before the start of the course on the course page on the Internet.
Machine Learning

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**Modulverantwortliche/r**  Prof. Dr. Isabel Valera

**Dozent/inn/en**  Prof. Dr. Isabel Valera

**Zulassungsvoraussetzungen**  The lecture gives a broad introduction into machine learning methods. After the lecture the students should be able to solve and analyze learning problems.

**Leistungskontrollen / Prüfungen**
- Regular attendance of classes and tutorials.
- 50% of all points of the exercises have to be obtained in order to qualify for the exam.
- Passing 1 out of 2 exams (final, re-exam).

**Lehrveranstaltungen / SWS**
4 h lectures
+ 2 h tutorial
= 6 h (weekly)

**Arbeitsaufwand**
90 h of classes
+ 180 h private study
= 270 h (= 9 ECTS)

**Modulnote**  Determined from the results of the exams, exercises and potential projects. The exact grading modalities are announced at the beginning of the course.

**Sprache**  English

**Lernziele / Kompetenzen**

The lecture gives a broad introduction into machine learning methods. After the lecture the students should be able to solve and analyze learning problems.

**Inhalt**
- Bayesian decision theory
- Linear classification and regression
- Kernel methods
- Bayesian learning
- Semi-supervised learning
- Unsupervised learning
- Model selection and evaluation of learning methods
- Statistical learning theory
- Other current research topics

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
### Operating Systems (OS)

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**Modulverantwortliche/r** Prof. Peter Druschel, Ph.D.

**Dozent/inn/en** Prof. Peter Druschel, Ph.D.
Björn Brandenburg, Ph.D.

**Zulassungsvoraussetzungen** For graduate students: none

**Leistungskontrollen / Prüfungen**
- Regular attendance at classes and tutorials
- Successful completion of a course project in teams of 2 students
- Passing 2 written exams (midterm and final exam)
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

**Lehrveranstaltungen / SWS**
- 4 h lectures
- + 2 h tutorial
- = 6 h (weekly)

**Arbeitsaufwand**
- 90 h of classes
- + 180 h private study
- = 270 h (= 9 ECTS)

**Modulnote** Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

**Sprache** English

**Lernziele / Kompetenzen**

Introduction to the principles, design, and implementation of operating systems

**Inhalt**

Process management:
- Threads and processes, synchronization
- Multiprogramming, CPU Scheduling
- Deadlock

Memory management:
- Dynamic storage allocation
- Sharing main memory
- Virtual memory

I/O management:
- File storage management
- Naming
- Concurrency, Robustness, Performance

Virtual machines
Literaturhinweise

Will be announced before the start of the course on the course page on the Internet.
## Optimization

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### Modulverantwortliche/r
Prof. Dr. Kurt Mehlhorn

### Dozent/inn/en
Prof. Dr. Kurt Mehlhorn
Dr. Andreas Karrenbauer

### Zulassungsvoraussetzungen
For graduate students: none

### Leistungskontrollen / Prüfungen
- Regular attendance of classes and tutorials
- Solving accompanying exercises, successful participation in midterm and final exam
- Grades: Yes
- The grade is calculated from the above parameters according to the following scheme: 20%, 30%, 50%
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

### Lehrveranstaltungen / SWS
- 4 h lectures
- 2 h tutorial
- = 6 h (weekly)

### Arbeitsaufwand
- 90 h of classes
- 180 h private study
- = 270 h (= 9 ECTS)

### Modulnote
Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

### Sprache
English

### Lernziele / Kompetenzen
The students learn to model and solve optimization problems from theory as from the real world

### Inhalt
Linear Programming: Theory of polyhedra, simplex algorithm, duality, ellipsoid method
Integer linear programming: Branch-and-Bound, cutting planes, TDI-Systems
Network flow: Minimum cost network flow, minimum mean cycle cancellation algorithm, network simplex method
Matchings in graphs: Polynomial matching algorithms in general graphs, integrality of the matching polytope, cutting planes
Approximation algorithms: LP-Rounding, greedy methods, knapsack, bin packing, steiner trees and forests, survivable network design

### Literaturhinweise
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**Modulverantwortliche/r**  Prof. Dr. Michael Backes

**Dozent/inn/en**  Prof. Dr. Michael Backes  Prof. Dr. Cas Cremers

**Zulassungsvoraussetzungen**  For graduate students: none

**Leistungskontrollen / Prüfungen**
- Regular attendance of classes and tutorials
- Passing the final exam
- A re-exam is normally provided (as written or oral examination).

**Lehrveranstaltungen / SWS**  4 h lectures + 2 h tutorial = 6 h (weekly)

**Arbeitsaufwand**  90 h of classes + 180 h private study = 270 h (= 9 ECTS)

**Modulnote**  Will be determined by the performance in exams, tutor groups, and practical tasks. Details will be announced by the lecturer at the beginning of the course.

**Sprache**  English

**Lernziele / Kompetenzen**
Description, assessment, development and application of security mechanisms, techniques and tools.

**Inhalt**

- Basic Cryptography,
- Specification and verification of security protocols,
- Security policies: access control, information flow analysis,
- Network security,
- Media security,
- Security engineering

**Literaturhinweise**
Will be announced on the course website
Semantics

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**Modulverantwortliche/r** Prof. Dr. Gert Smolka

**Dozent/inn/en** Prof. Dr. Gert Smolka

**Zulassungsvoraussetzungen** For graduate students: core lecture Introduction to Computational Logic

**Leistungskontrollen / Prüfungen**
- Regular attendance of classes and tutorials.
- Passing the midterm and the final exam

**Lehrveranstaltungen / SWS**
- 4 h lectures
- + 2 h tutorial
= 6 h (weekly)

**Arbeitsaufwand**
- 90 h of classes
- + 180 h private study
= 270 h (= 9 ECTS)

**Modulnote** Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

**Sprache** English

**Lernziele / Kompetenzen**

Understanding of
- Logical structure of programming languages
- Formal models of programming languages
- Type and module systems for programming languages

**Inhalt**

Theory of programming languages, in particular:
- Formal models of functional and object-oriented languages
- Lambda Calculi (untyped, simply typed, System F, F-omega, Lambda Cube, subtyping, recursive types, Curry-Howard Correspondence)
- Algorithms for type checking and type reconstruction

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
Modulverantwortliche/r  Prof. Dr. Sven Apel
Dozent/inn/en  Prof. Dr. Sven Apel

Zulassungsvoraussetzungen  • Knowledge of programming concepts (as taught in the lectures *Programmierung 1* and *Programmierung 2*)
• Basic knowledge of software processes, design, and testing (as taught and applied in the lecture *Softwarepraktikum*)

Leistungskontrollen / Prüfungen  Beside the lecture and weekly practical exercises, there will be a number of assignments in the form of mini-projects for each student to work on (every two to three weeks). The assignments will be assessed based on the principles covered in the lecture. Passing all assignments is a prerequisite for taking the final written exam. The final grade is determined only by the written exam. Further examination details will be announced by the lecturer at the beginning of the course. In short:
• Passing all assignments (prerequisite for the written exam)
• Passing the written exam

Lehrveranstaltungen / SWS  4 h lectures
+ 2 h exercises
= 6 h (weekly)

Arbeitsaufwand  90 h of classes and exercises
+ 180 h private study and assignments
= 270 h (= 9 ECTS)

Modulnote  The grade is determined by the written exam. Passing all assignments is a prerequisite for taking the written exam. The assignments do not contribute to the final grade. Further examination details will be announced by the lecturer at the beginning of the course.

Sprache  English

Lernziele / Kompetenzen

• The students know and apply modern software development techniques.
• They are aware of key factors contributing to the complexity of real-world software systems, in particular, software variability, configurability, feature interaction, crosscutting concerns, and how to address them.
• They know how to apply established design and implementation techniques to master software complexity.
• They are aware of advanced design and implementation techniques, including collaboration-based design, mixins/traits, aspects, pointcuts, advice.
• They are aware of advanced quality assurance techniques that take the complexity of real-world software systems into account: variability-aware analysis, sampling, feature-interaction detection, predictive performance modeling, etc.
• They appreciate the role of non-functional properties and know how to predict and optimize software systems regarding these properties.
• They are able to use formal methods to reason about key techniques and properties covered in the lecture.

Inhalt

• Domain analysis, feature modeling
• Automated reasoning about software configuration using SAT solvers
• Runtime parameters, design patterns, frameworks
• Version control, build systems, preprocessors
• Collaboration-based design
• Aspects, pointcuts, advice
• Expression problem, preplanning problem, code scattering & tangling, tyranny of the dominant decomposition, inheritance vs. delegation vs. mixin composition
• Feature interaction problem (structural, control- & data-flow, behavioral, non-functional feature interactions)
• Variability-aware analysis and variational program representation (with applications to type checking and static program analysis)
• Sampling (random, coverage)
• Machine learning for software performance prediction and optimization

Literaturhinweise

**Modulverantwortliche/r**  Prof. Dr.-Ing. Holger Hermanns

**Dozent/inn/en**  Prof. Dr.-Ing. Holger Hermanns  
Prof. Bernd Finkbeiner, Ph.D

**Zulassungsvoraussetzungen**  For graduate students: none

**Leistungskontrollen / Prüfungen**
- Regular attendance of classes and tutorials
- Passing the final exam
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

**Lehrveranstaltungen / SWS**
- 4 h lectures  
- + 2 h tutorial  
- = 6 h (weekly)

**Arbeitsaufwand**
- 90 h of classes  
- + 180 h private study  
- = 270 h (= 9 ECTS)

**Modulnote**  Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

**Sprache**  English

**Lernziele / Kompetenzen**

The students become familiar with the standard methods in computer-aided verification. They understand the theoretical foundations and are able to assess the advantages and disadvantages of different methods for a specific verification project. The students gain first experience with manual correctness proofs and with the use of verification tools.

**Inhalt**

- models of computation and specification languages: temporal logics, automata over infinite objects, process algebra  
- deductive verification: proof systems (e.g., Floyd, Hoare, Manna/Pnueli), relative completeness, compositionality  
- model checking: complexity of model checking algorithms, symbolic model checking, abstraction case studies

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
Modulbereich 2

Vertiefungsvorlesungen
Audio/Visual Communication and Networks

<table>
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**Modulverantwortliche/r**  Prof. Dr.-Ing. Thorsten Herfet

**Dozent/inn/en**  Prof. Dr.-Ing. Thorsten Herfet

**Zulassungsvoraussetzungen**  Solid foundation of mathematics (differential and integral calculus) and probability theory. The course will build on the mathematical concepts and tools taught in TC I while trying to enable everyone to follow and to fill gaps by an accelerated study of the accompanying literature. *Signals and Systems* as well as *Digital Transmission and Signal Processing (TC I)* are strongly recommended but not required.

**Leistungskontrollen / Prüfungen**  Regular attendance of classes and tutorials. Passing the final exam. Oral exam directly succeeding the course. Eligibility: Weekly exercises / task sheets, grouped into two blocks corresponding to first and second half of the lecture. Students must provide min. 50% grade in each of the two blocks to be eligible for the exam.

**Lehrveranstaltungen / SWS**

- 4 h lectures
- + 2 h tutorial
- = 6 h (weekly)

**Arbeitsaufwand**

- 90 h of classes
- + 180 h private study
- = 270 h (= 9 ECTS)

**Modulnote**  Final Exam Mark

**Sprache**  English

**Lernziele / Kompetenzen**

AVCN will deepen the students' knowledge on modern communications systems and will focus on wireless systems.

Since from a telecommunications perspective the combination of audio/visual data – meaning inherently high data rate and putting high requirements on the realtime capabilities of the underlying network – and wireless transmission – that is unreliable and highly dynamic with respect to the channel characteristics and its capacity – is the most demanding application domain.

**Inhalt**

As the basic principle the course will study and introduce the building blocks of wireless communication systems. Multiple access schemes like TDMA, FDMA, CDMA and SDMA are introduced, antennas and propagation incl. link budget calculations are dealt with and more advanced channel models like MIMO are investigated. Modulation and error correction technologies presented in Telecommunications I will be expanded by e.g. turbo coding and receiver architectures like RAKE and BLAST will be introduced. A noticeable portion of the lecture will present existing and future wireless networks and their extensions for audio/visual data. Examples include 802.11n and the terrestrial DVB system (DVB-T2).

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
Weitere Informationen

This module was formerly also known as *Telecommunications II.*
Lernziele / Kompetenzen

The students will gain a deep understanding of the automata-theoretic background of automated verification and program synthesis.

Inhalt

The theory of automata over infinite objects provides a succinct, expressive and formal framework for reasoning about reactive systems, such as communication protocols and control systems. Reactive systems are characterized by their nonterminating behaviour and persistent interaction with their environment.

In this course we study the main ingredients of this elegant theory, and its application to automatic verification (model checking) and program synthesis.

- Automata over infinite words and trees (omega-automata)
- Infinite two-person games
- Logical systems for the specification of nonterminating behavior
- Transformation of automata according to logical operations

Literaturhinweise

Will be announced before the start of the course on the course page on the Internet.
Automated Debugging

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**Modulverantwortliche/r** Prof. Dr. Andreas Zeller  
**Dozent/inn/en** Prof. Dr. Andreas Zeller  
**Zulassungsvoraussetzungen** *Programmierung 1, Programmierung 2* and *Softwarepraktikum*  
**Leistungskontrollen / Prüfungen** Projects and mini-tests

**Lehrveranstaltungen / SWS**  
2 h lectures  
+ 2 h tutorial  
= 4 h (weekly)

**Arbeitsaufwand**  
60 h of classes  
+ 120 h private study  
= 180 h (= 6 ECTS)

**Modulnote** The module is passed in its entirety if the examination performance has been passed.

**Sprache** English

**Lernziele / Kompetenzen**

Finding and fixing software bugs can involve lots of effort. This course addresses this problem by automating software debugging, specifically identifying failure causes, locating bugs, and fixing them. Students learn the basics of systematic debugging, and explore tools and techniques for automated debugging.

**Inhalt**

- Tracking Problems  
- The Scientific Method  
- Cause-Effect Chains  
- Building a Debugger  
- Tracking Inputs  
- Assertions and Sanitizers  
- Detecting Anomalies  
- Statistical Fault Localization  
- Generating Tests  
- Reducing Failure-Inducing Inputs  
- Mining Software Archives  
- Fixing the Defect  
- Repairing Bugs Automatically  
- Managing Bugs

**Literaturhinweise**

The teaching material consists of text, Python code, and Jupyter Notebooks from the textbook "The Debugging Book" (https://www.debuggingbook.org/), also in English.
### Computer Architecture 2

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**Modulverantwortliche/r**  Prof. Dr. W.-J. Paul  
**Dozent/inn/en**  Prof. Dr. W.-J. Paul

**Zulassungsvoraussetzungen**  Related core lecture *Computer Architecture*

**Leistungskontrollen / Prüfungen**

- **Studying:** Students should listen to the lectures, read the lecture notes afterwards and understand them. They should solve the exercises alone or in groups. Students must present and explain their solutions during the tutorials.

- **Exams:** Students who have solved 50% of all exercises are allowed to participate in an oral exam. A re-exam takes place during the last two weeks before the start of lectures in the following semester.

**Lehrveranstaltungen / SWS**

- 4 h lectures  
  + 2 h tutorial  
  = 6 h (weekly)

**Arbeitsaufwand**

- 90 h of classes  
  + 180 h private study  
  = 270 h ( = 9 ECTS)

**Modulnote**  Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

**Sprache**  English

### Lernziele / Kompetenzen

After this lecture students know how to design IEEE compatible floating point units and some form of parallel computer system.

### Inhalt

General comment: constructions are usually presented together with correctness proofs; Below you find the 2005/2006 Version of this lecture

- Basics of Floating Point Computation  
  - IEEE standard  
  - Theory of rounding
- FPU construction  
  - Add/subtract unit  
  - Multiply/divide unit  
  - Rounding
- Automotive systems hardware  
  - Serial interfaces  
  - Clock Synchronization  
  - FlexRay like Interfaces  
  - Electronic control units
- Automotive systems software  
  - An OSEKTime like programming model
- An OSEKTime like real time operating system
- Drivers
- Worst Case Execution Time
- Pervasive Correctness proof

**Literaturhinweise**

Will be announced before the start of the course on the course page on the Internet.
Correspondence Problems in Computer Vision

### Modulverantwortliche/r
Prof. Dr. Joachim Weickert

### Dozent/inn/en
Dr. Pascal Peter

### Zulassungsvoraussetzungen
Undergraduate mathematics (e.g. "Mathematik für Informatiker I-III") is required, as well as elementary C knowledge (for the programming assignments). Knowledge in image processing or differential equations is useful.

### Leistungskontrollen / Prüfungen
- Regular attendance of lecture and tutorial
- Written or oral exam and the end of the course

### Lehrveranstaltungen / SWS
2 h lectures
+ 2 h tutorial
= 4 h (weekly)

### Arbeitsaufwand
60 h of classes
+ 120 h private study
= 180 h (= 6 ECTS)

### Modulnote
Will be determined from performance in exams. The exact modalities will be announced at the beginning of the module.

### Sprache
English

## Lernziele / Kompetenzen

Correspondence problems are a central topic in computer vision. Thereby, one is interested in identifying and matching corresponding features in different images/views of the same scene. Typical correspondence problems are the estimation of motion information from consecutive frames of an image sequence (optic flow), the reconstruction of a 3-D scene from a stereo image pair and the registration of medical image data from different modalities (e.g. CT and MRT). Central part of this lecture is the discussion of the most important correspondence problems as well as the modelling of suitable algorithms for solving them.

## Inhalt

1. Introduction and Overview
2. General Matching Concepts
   2.1 Block Matching
   2.2 Correlation Techniques
   2.3 Interest Points
   2.4 Feature-Based Methods
3. Optic Flow I
   3.1 Local Differential Methods
   3.2 Parameterisation Models
4. Optic Flow II
   4.1 Global Differential Methods
   4.2 Horn and Schunck
5. Optic Flow III
   5.1 Advanced Constancy Assumptions
   5.2 Large Motion
6. Optic Flow IV
6.1 Robust Data Terms
6.2 Discontinuity-Preserving Smoothness Terms
7. Optic Flow V
  7.1 High Accuracy Methods
  7.2 SOR and Linear Multigrid
8. Stereo Matching I
  8.1 Projective Geometry
  8.2 Epipolar Geometry
9. Stereo Matching II
  9.1 Estimation of the Fundamental Matrix
10. Stereo Matching III
  10.1 Correlation Methods
  10.2 Variational Approaches
  10.3 Graph Cuts
11. Medical Image Registration
  11.1 Mutual Information
  11.2 Elastic and Curvature Based Registration
  11.3 Landmarks
12. Particle Image Velocimetry
  12.1 Div-Curl-Regularisation
  12.2 Incompressible Navier Stokes Prior

Literaturhinweise

Will be announced before the start of the course on the course page on the Internet.
Introduction to Image Acquisition Methods

<table>
<thead>
<tr>
<th>Studiensem.</th>
<th>Regelst. sem.</th>
<th>Turnus</th>
<th>Dauer</th>
<th>SWS</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
<td>at least every two years</td>
<td>1 semester</td>
<td>2</td>
<td>4</td>
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**Modulverantwortliche/r**  Prof. Dr. Joachim Weickert  
**Dozent/inn/en**  N.N.  
**Zulassungsvoraussetzungen**  Related core lecture Computer Vision  
**Leistungskontrollen / Prüfungen**  
- Written or oral exam at end of course  
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.  
**Lehrveranstaltungen / SWS**  2 h lectures (weekly)  
**Arbeitsaufwand**  
- 30 h of classes  
+ 90 h private study  
= 120 h (= 4 ECTS)  
**Modulnote**  Will be determined from performance in exams, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.  
**Sprache**  English  

**Lernziele / Kompetenzen**  
The course is designed as a supplement for image processing lectures, to be attended before, after or parallel to them. Participants shall understand  
- what are digital images  
- how they are acquired  
- what they encode and what they mean  
- which limitations are introduced by the image acquisition.  
This knowledge will be helpful in selecting adequate methods for processing image data arising from different methods.  

**Inhalt**  
A broad variety of image acquisition methods is described, including imaging by virtually all sorts of electromagnetic waves, acoustic imaging, magnetic resonance imaging and more. While medical imaging methods play an important role, the overview is not limited to them.  
Starting from physical foundations, description of each image acquisition method extends via aspects of technical realisation to mathematical modelling and representation of the data.  

**Literaturhinweise**  
Will be announced before the start of the course on the course page on the Internet.
Modulbereich 3

Seminare
Modulverantwortliche/r  Studiendekan der Fakultät Mathematik und Informatik
Studienbeauftragter der Informatik

Dozent/inn/en  Dozent/inn/en der Fachrichtung

Zulassungsvoraussetzungen  Grundlegende Kenntnisse im jeweiligen Teilbereich des Studienganges.

Leistungskontrollen / Prüfungen  
- Thematischer Vortrag mit anschließender Diskussion
- Aktive Teilnahme an der Diskussion
- Gegebenenfalls schriftliche Ausarbeitung oder Projekt

Lehrveranstaltungen / SWS  2 SWS Seminar

Arbeitsaufwand  30 h Präsenzstudium
+ 180 h Eigenstudium
= 210 h (= 7 ECTS)


Sprache  Deutsch oder Englisch

Lernziele / Kompetenzen

Die Studierenden haben am Ende der Veranstaltung vor allem ein tiefes Verständnis aktueller oder fundamentaler Aspekte eines spezifischen Teilbereiches der Informatik erlangt.

Sie haben weitere Kompetenz im eigenständigen wissenschaftlichen Recherchieren, Einordnen, Zusammenfassen, Diskutieren, Kritisieren und Präsentieren von wissenschaftlichen Erkenntnissen gewonnen.

Inhalt

Weitgehend selbstständiges Erarbeiten des Seminarthemas:

- Lesen und Verstehen wissenschaftlicher Arbeiten
- Analyse und Bewertung wissenschaftlicher Aufsätze
- Diskutieren der Arbeiten in der Gruppe
- Analysieren, Zusammenfassen und Wiedergeben des spezifischen Themas
- Erarbeiten gemeinsamer Standards für wissenschaftliches Arbeit
- Präsentationstechnik

Spezifische Vertiefung in Bezug auf das individuelle Thema des Seminars.

Der typische Ablauf eines Seminars ist üblicherweise wie folgt:

- Vorbereitende Gespräche zur Themenauswahl
- Regelmäßige Treffen mit Diskussion ausgewählter Beiträge
- ggf. Bearbeitung eines themenbegleitenden Projekts
- Vortrag und ggf. Ausarbeitung zu einem der Beiträge
Literaturhinweise

Material wird dem Thema entsprechend ausgewählt.

Weitere Informationen

Die jeweils zur Verfügung stehenden Seminare werden vor Beginn des Semesters angekündigt und unterscheiden sich je nach Studiengang.
Modulbereich 4

HBKsaar
**MAD-Projekt**

<table>
<thead>
<tr>
<th>Studiensem.</th>
<th>Regelst.sem.</th>
<th>Turnus</th>
<th>Dauer</th>
<th>SWS</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>jedes Semester</td>
<td>1 Semester</td>
<td></td>
<td>8</td>
<td>8</td>
<td></td>
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</table>

**Modulverantwortliche/r**
Dozent/inn/en der Hochschule der Bildenden Künste (HBKsaar)

**Dozent/inn/en**
Dozent/inn/en der Hochschule der Bildenden Künste (HBKsaar)

**Zulassungsvoraussetzungen**
Grundlagen Media Art & Design (empfohlen)

**Leistungskontrollen / Prüfungen**
Projektarbeit, Projektdokumentation, Projektpräsentation

**Lehrveranstaltungen / SWS**
8 SWS Projektarbeit

**Arbeitsaufwand**
- 120 h Projektarbeit
- + 120 h Vor- und Nachbereitung
  (Projektrecherche und -dokumentation)
- 240 h (= 8 ECTS)

**Modulnote**
Das Modul ist insgesamt bestanden, wenn die Prüfungsleistung bestanden wurde. (benotet)

**Sprache**
Deutsch oder Englisch

### Lernziele / Kompetenzen

Die konkreten Lernziele der einzelnen Veranstaltungen werden jährlich von der Hochschule der Bildenden Künste (HBKsaar) aktualisiert und bekannt gegeben. Kurzüberblick der vermittelten Kompetenzen:

- Reflexion diverser Medien, Materialien und Methoden
- Kritische Reflexion medialer Bildwelten und von Phänomenen der Alltagsästhetik sowie deren Darstellung in rhetorischen Grundformen
- Bewirken ästhetischer Entscheidungen in Gestaltungsprozessen sowie deren begründete Reflexion
- Entwurf, Vorbereitung und Durchführung eines eigenständig bearbeiteten Projekts
- Projektdokumentation, die das Projekt und die eigene Leistung dokumentiert
- Präsentation der eigenen Arbeit in einem Ateliergespräch oder einer Ausstellung

### Inhalt


### Literaturhinweise

Die Literatur zum Modul kann englisch- und/oder deutschsprachig sein und wird zu Beginn der Veranstaltung bekannt gegeben.

### Weitere Informationen

Die zugehörigen Veranstaltungen werden im Vorlesungszechnis der HBKsaar als Atelierprojekt kurz bezeichnet.
Modulbereich 5

Praktikumsphase
**Berufspraktikum & Praktikumsseminar**

<table>
<thead>
<tr>
<th>Studiensem.</th>
<th>Regelst. sem.</th>
<th>Turnus</th>
<th>Dauer</th>
<th>SWS</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>Jedes Sommersemester</td>
<td>1 Semester</td>
<td>PRAKTIKUM</td>
<td>20+5</td>
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</tbody>
</table>

**Modulverantwortliche/r** Prof. Dr. Antonio Krüger

**Dozent/inn/en** Prof. Dr. Antonio Krüger

**Zulassungsvoraussetzungen** Genehmigung des Themengebietes und Inhalts des Berufspraktikums durch die Fachstudienberatung oder den Prüfungsausschuss nach §6 Praktikumsphase der Studienordnung.

**Leistungskontrollen / Prüfungen** Projektaufgabe, Praktikumsbericht und Kolloquium.

**Lehrveranstaltungen / SWS**

**Modul: Berufspraktikum:**
Projektaufgabe in der Industrie oder der Forschung nach §6 Praktikumsphase der Studienordnung.

**Modul: Praktikumsseminar:**
Vortrag über das durchgeführte Berufspraktikum, Praktikumsbericht, und Teilnahme am Kolloquium.

**Arbeitsaufwand**
- 600 h Berufspraktikum
- 150 h Praktikumsseminar
= 750 h (= 25 ECTS)

**Modulnote** Das Modul ist insgesamt bestanden, wenn die Prüfungsleistung bestanden wurde (Berufspraktikum: unbenotet, Praktikumsseminar: benotet). Modulnote aus der Beurteilung des abschließenden Kolloquiums.

**Sprache** Deutsch oder Englisch

**Lernziele / Kompetenzen**

Das Berufspraktikum ist ein Praktikum zu einem Themengebiet der Medieninformatik oder einem verwandten Fachgebiet wie bspw. Informatik, das in der Industrie oder der Forschung durchgeführt wird.

Die Praktikumsphase soll die Studierenden befähigen, wissenschaftliche oder industrielle Aufgabenstellungen aus dem Bereich der Medieninformatik oder einem verwandten Fachgebiet wie bspw. Informatik ganzheitlich zu bearbeiten und die Ergebnisse in nachvollziehbarer Form zu dokumentieren, auszuarbeiten und in einem Praktikumsseminar zu präsentieren.

Ziel des Berufspraktikums ist die Anwendung fachspezifischen Wissens zur Bearbeitung realitätsnaher Aufgabenstellungen, die Fähigkeit zur Selbstorganisation und die Eingliederung in ein bestehendes Projektteam.

- Umsetzung und Anwendung der Lehrinhalte des Studiengangs
- Zielorientiertes Arbeiten in einem Team unter Randbedingungen der Industrie
- Fähigkeit zur Präsentation und Verteidigung der Ergebnisse

**Inhalt**

- Bearbeitung eines Themengebietes der Medieninformatik in einem industriellen Umfeld
- Aufbereitung und Anwendung von Fachwissen und Methoden
- Erarbeitung, Erprobung und Bewertung von Lösungsansätzen
- selbstorganisierte Teamarbeit und Rollenverteilung
- Dokumentation des Praktikumsverlaufs und der Projektarbeit
- Präsentation der Arbeiten und Ergebnisse in einem Vortrag mit abschließendem Kolloquium
Literaturhinweise

Material wird dem Thema entsprechend ausgewählt.
Modulbereich 6

Master-Seminar und -Arbeit
Master Seminar

<table>
<thead>
<tr>
<th>Stu.sem.</th>
<th>Regelst.sem.</th>
<th>Turnus</th>
<th>Dauer</th>
<th>SWS</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
<td>every semester</td>
<td>1 semester</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

**Modulverantwortliche/r**
Dean of Studies of the Faculty of Mathematics and Computer Science
Study representative of computer science

**Dozent/inn/en**
Professors of the department

**Zulassungsvoraussetzungen**
Acquisition of at least 30 CP

**Leistungskontrollen / Prüfungen**
- Preparation of the relevant scientific literature
- Written elaboration of the topic of the master thesis
- Presentation about the planned topic with subsequent discussion
- Active participation in the discussion

**Lehrveranstaltungen / SWS**
2 h seminar (weekly)

**Arbeitsaufwand**
- 30 h seminar
- 40 h contact with supervisor
- 290 h private study
= 360 h (= 12 ECTS)

**Modulnote**
graded

**Sprache**
English or German

**Lernziele / Kompetenzen**
The Master seminar sets the ground for carrying out independent research within the context of an appropriately demanding research area. This area provides sufficient room for developing own scientific ideas.

At the end of the Master seminar, the basics ingredients needed to embark on a successful Master thesis project have been explored and discussed with peers, and the main scientific solution techniques are established.

The Master seminar thus prepares the topic of the Master thesis. It does so while deepening the students' capabilities to perform a scientific discourse. These capabilities are practiced by active participation in a reading group. This reading group explores and discusses scientifically demanding topics of a coherent subject area.

**Inhalt**
The methods of computer science are systematically applied, on the basis of the "state-of-the-art".

**Literaturhinweise**
Scientific articles corresponding to the topic area in close consultation with the lecturer.
Master Thesis

<table>
<thead>
<tr>
<th>Studiensem.</th>
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<th>SWS</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>every semester</td>
<td>6 months</td>
<td>-</td>
<td>30</td>
</tr>
</tbody>
</table>

**Modulverantwortliche/r**
Dean of Studies of the Faculty of Mathematics and Computer Science
Study representative of computer science

**Dozent/inn/en**
Professors of the department

**Zulassungsvoraussetzungen**
Successful completion of the Master Seminar

**Leistungskontrollen / Prüfungen**
Written elaboration in form of a scientific paper. It describes the scientific findings as well as the way leading to these findings. It contains justifications for decisions regarding chosen methods for the thesis and discarded alternatives. The student’s own substantial contribution to the achieved results has to be evident. In addition, the student presents his work in a colloquium, in which the scientific quality and the scientific independence of his achievements are evaluated.

**Lehrveranstaltungen / SWS**
one

**Arbeitsaufwand**
50 h contact with supervisor  
+ 850 h private study  
= 900 h (= 30 ECTS)

**Modulnote**
Grading of the Master Thesis

**Sprache**
English or German

**Lernziele / Kompetenzen**
In the master thesis the student demonstrates his ability to perform independent scientific work focusing on an adequately challenging topic prepared in the master seminar.

**Inhalt**
In the master thesis the student demonstrates his ability to perform independent scientific work focusing on an adequately challenging topic prepared in the master seminar.

**Literaturhinweise**
According to the topic