



UNIVERSITÄT
DES
SAARLANDES

FAKULTÄT FÜR MATHEMATIK UND INFORMATIK

MODULHANDBUCH

Medieninformatik MSc

15. Juli 2021

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Modulbereich 1

Stammvorlesungen

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

Modulverantwortliche/r Prof. Dr. Kurt Mehlhorn

Dozent/inn/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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

Modulverantwortliche/r Prof. Dr. Jörg Hoffmann

Dozent/inn/en Prof. Dr. Jörg Hoffmann
Prof. Dr. Jana Köhler

Zulassungsvoraussetzungen For graduate students: none

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

Problem-solving:

- Uninformed- and informed search procedures
- Adversarial search

Knowledge and reasoning:

- Propositional logic
- SAT
- First-order logic, Inference in first-order logic
- Knowledge representation, Semantic Web
- Default logic, rule-based mechanisms

Planning:

- STRIPS formalism and complexity
- Delete relaxation heuristics

Probabilistic reasoning:

- Basic probabilistic methods
- Bayesian networks

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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-Vazirani 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

Arora, Barak: Computational Complexity – A Modern Approach, Cambridge University Press
Oded Goldreich: Computational Complexity – A Conceptual Approach, Cambridge University Press
Dexter Kozen: Theory of Computation, Springer
Schöning, Pruim: Gems of Theoretical Computer Science, Springer

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

Modulverantwortliche/r Prof. Dr. Philipp Slusallek

Dozent/inn/en Prof. Dr. Philipp Slusallek

Zulassungsvoraussetzungen Solid knowledge of linear algebra is recommended.

Leistungskontrollen / Prüfungen

- Successful completion of weekly exercises (30% of final grade)
- Successful participation in rendering competition (10%)
- Mid-term written exam (20%, final exam prerequisite)
- Final written exam (40%)
- In each of the above a minimum of 50% is required to pass

A re-exam typically 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 The grade is derived from the above assessments. Possible changes will be announced at the beginning of each semester.

Sprache English

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 applications 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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

Modulverantwortliche/r Prof. Dr. Michael Backes

Dozent/inn/en Prof. Dr. Markus Bläser
Dr. Nico Döttling

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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*.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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

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

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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 air plane, 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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

Modulverantwortliche/r Prof. Dr. Joachim Weickert

Dozent/inn/en 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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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

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

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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

- Feature-Oriented Software Product Lines: Concepts and Implementation. S. Apel, et al., Springer, 2013.
- Generative Programming: Methods, Tools, and Applications: Methods, Techniques and Applications. K. Czarnecki, et al., Addison-Wesley, 2000.
- Mastering Software Variability with FeatureIDE. J. Meinicke, et al., Springer, 2017.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 1 | 4 | at least every two years | 1 semester | 6 | 9 |

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

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 3 | 4 | at least every two years | 1 semester | 6 | 9 |

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 excersises / 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*.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 3 | 4 | at least every two years | 1 semester | 4 | 6 |

Modulverantwortliche/r Prof. Bernd Finkbeiner, Ph.D

Dozent/inn/en Prof. Bernd Finkbeiner, Ph.D

Zulassungsvoraussetzungen keine

Leistungskontrollen / Prüfungen

- Regular attendance of classes and tutorial
- Final exam
- A re-exam takes place during the last two weeks before the start of lectures in the following semester.

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, exercises and practical tasks. The exact modalities will be announced at the beginning of the module.

Sprache English

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

| | | | | | |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
| 3 | 4 | at least every two years | 1 semester | 4 | 6 |

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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 3 | 4 | at least every two years | 1 semester | 6 | 9 |

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 to 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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|-------------------|-------------------|----------|----------|
| 3 | 4 | occasional | 1 semester | 4 | 6 |

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 Liemar 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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|---------------------------------|-------------------|----------|----------|
| 3 | 4 | at least every two years | 1 semester | 2 | 4 |

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.

Seminar

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|-----------------------|-------------------|----------|----------|
| 1 | 4 | jedes Semester | 1 Semester | 2 | 7 |

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)

Modulnote Wird aus den Leistungen im Vortrag und der schriftlichen Ausarbeitung und/oder dem Seminarprojekt ermittelt. Die genauen Modalitäten werden von dem/der jeweiligen Dozenten/in bekannt gegeben.

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 wissenschaftliche 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.

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|----------------|------------|-----|------|
| | | jedes Semester | 1 Semester | - | 8 |

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 •

Arbeitsaufwand 360 h Projektarbeit
+ 120 h Vor- und Nachbereitung (Projektrecherche und -dokumentation)
= 480 h (= 16 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 (HBK Saar) 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

Die konkreten Inhalte orientieren sich an den angebotenen Projektarbeiten und werden jährlich von der Hochschule der Bildenden Künste (HBK Saar) aktualisiert und bekannt gegeben. Die Themen spannen einen attraktiven Bogen von aktueller Forschung zu anspruchsvollen Problemen der industriellen Praxis.

Literaturhinweise

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

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|----------------------|------------|-----|------|
| | | jedes Sommersemester | 1 Semester | - | 8 |

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 •

Arbeitsaufwand 180 h Projektarbeit
 + 60 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 (HBK Saar) 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

Die konkreten Inhalte orientieren sich an den angebotenen Projektarbeiten und werden jährlich von der Hochschule der Bildenden Künste (HBK Saar) aktualisiert und bekannt gegeben. Die Themen spannen einen attraktiven Bogen von aktueller Forschung zu anspruchsvollen Problemen der industriellen Praxis.

Literaturhinweise

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

Modulbereich 5

Praktikumsphase

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|----------------------|------------|------------------|-------------|
| 2 | 4 | jedes Sommersemester | 1 Semester | PRAKTIKUM | 20+5 |

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 Projektarbeit, Praktikumsbericht und Kolloquium.

Lehrveranstaltungen / SWS **Modul: Berufspraktikum:**
Projektarbeit 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

| | | | | | |
|-------------|--------------|-----------------------|-------------------|----------|-----------|
| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
| 3 | 4 | every semester | 1 semester | 2 | 12 |

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

| Studiensem. | Regelst.sem. | Turnus | Dauer | SWS | ECTS |
|-------------|--------------|-----------------------|-----------------|----------|-----------|
| 4 | 4 | every semester | 6 months | - | 30 |

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 none

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