HOCHSCHULE
HANNOVER
UNIVERSITY OF
APPLIED SCIENCES
AND ARTS
–
Fakultät IV
Wirtschaft und
Informatik

Module description
Master in Computer Science, PO Version of 2013 (WT)

Contents

IT Security

Information Systems

Software Technology

Module MIN-301 Software Architecture

Subheading	(MIN-SWA)
Level of Module	Basic module
Type of Module	Compulsory module
Submodules	MIN-301-01 Software Architecture, Compulsory
Person in Charge	Dunkel, Jürgen, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	1
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	none
Examination	Examination (written or oral) and experimental work

Learning Outcomes

Technological skills: in-depth knowledge of software architecture principles and design methodologies.
Methodological competence: modeling complex software archiectures with formal methods.
Analysis design und implementation competence: capability of defining the requirements and critical success factors of software architectures; applying formal methods for describing software architectures; using software architectures as basis for implementing complex software systems

Submodule MIN-301-01 Software Architecture

Subheading	(MIN-SWA)
Person in Charge	Dunkel, Jürgen, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	1
Suggestions for Independent Study	see literature
Recommended Prerequisites	none
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Technological skills: in-depth knowledge of software architecture principles and design methodologies.
Methodological competence: modeling complex software archiectures with formal methods.
Analysis design und implementation competence: capability of defining the requirements and critical success factors of software architectures; applying formal methods for describing software architectures; using software architectures as basis for implementing complex software systems

Content

Basic concepts and characteristics of modern software architectures, design principles and advanced technologies used in complex software architectures. For instance: components and connectors, architectural patterns and styles, design by contract with OCL, Domain Driven Design, model-driven software development, business process modeling.

Requirements for Contact Hours

Active participation, solving exercises, project work

Requirements for Independent Study Hours

Pre- and post-preparation of the content

Bibliography

R. N. Taylor, N. Medvidovic, E. M. Dashofy, Software Architecture: Foundations, Theory, and Practice, Wiley, 2009.
G. Fairbanks, Just Enough Software Architecture: A Risk-Driven Approach, Marshall & Brainerd, 2010.
E. Evans: Domain-Driven Design, Addison Wesley, 2004
M. Voelter: DSL Engineering: Designing, Implementing and Using Domain Specific Languages, (http.:dslbook.org), 2013.

Module MIN-302 Project and Quality Management

Subheading	Introduction to basic forms of organization and processes (MIN-PMQM)
Level of Module	Basic module
Type of Module	Compulsory module
Submodules	MIN-302-01 Project and Quality Management, Compulsory
Person in Charge	Salzwedel, Jussi, M.Sc.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	1
Duration of Module	1 semester
Prerequisites	None
Recommended Prerequisites	Successful completion of a Bachelor's degree program with the focus on computer science that is at least comparable to programming and software engineering courses.
Examination	Examination (written or oral examination) and experimental work.

Learning Outcomes

Analysis, design, and methodological skills: Students acquire the ability to work independently in their field of profession. They learn about methods and concepts relating to project and quality management in order to be able to work as a team leader in a team, which can consist of members from a number of different disciplines and with different levels of competence.

Submodule MIN-302-01 Project and Quality Management

Subheading	Introduction to basic forms of organization and processes (MIN-PMQM)
Person in Charge	Salzwedel, Jussi, M.Sc.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	1
Suggestions for Independent Study	see literature references
Recommended Prerequisites	none
Examination	Examination (written or oral) and experimental work

Learning Outcomes

Analysis, design, and methodological skills: Students acquire the ability to work independently in their field of profession. They learn methods and concepts relating to project and quality management in order to be able to work as a team leader in a team, that can consist of members from a number of different disciplines and with different levels of competence.

Content

Introduction to basic organizational structures and processes with the goal of executing projects. These include
project acquisition,
project organization and planning,
measures for project controlling and risk management,
configuration management,
and quality control measures.
In addition, process quality ensuring procedural models, such as ISO 9000 or CMM, are discussed.

Requirements for Contact Hours

68

Requirements for Independent Study Hours

112

Bibliography

DeMarco, T., Lister, T.: Wien wartet auf Dich, Hanser.
DeMarco, T.: Der Termin, Hanser.
Balzert, H.: Lehrbuch der Software-Technik 1/2. Spektrum.
Cockburn, A.: Agile Software-Entwicklung, Mitp (or English original). Beck, K., Andres, C.: Extreme Programming Explained (and: Kent Beck: Extreme Programming).
Other sources on Advanced topics.

Module MIN-303 Visualization and HCI

Subheading	(MIN-VISH)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-303-01 Visualization and HCI, Compulsory
Person in Charge	Ahlers, Volker, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	2
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	none
Examination	Written or oral examination, experimental work

Learning Outcomes

Algorithmic and mathematical skills: Knowledge of the basic principles of human-computer interaction (HCI), understanding of visualization algorithms, knowledge of different types of data representation.
Analysis, design, and realization skills: Analysis of data sets and visualization requirements, design and realization of visualization solutions, implementation of algorithms.
Technological skills: Knowledge of the use of visualization techniques in different areas of application.
Methodological skills: Knowledge of the opportunities, the benefits, and the limits of the use of visualization techniques, detection of errors in visualization solutions.

Submodule MIN-303-01 Visualization and HCI

Subheading	(MIN-VISH)
Person in Charge	Ahlers, Volker, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	2
Suggestions for Independent Study	see literature
Recommended Prerequisites	none
Examination	Written or oral examination, experimental work

Learning Outcomes

Algorithmic and mathematical skills: Knowledge of the basic principles of human-computer interaction (HCI), understanding of visualization algorithms, knowledge of different types of data representation.
Analysis, design, and realization skills: Analysis of data sets and visualization requirements, design and realization of visualization solutions, implementation of algorithms.
Technological skills: Knowledge of the use of visualization techniques in different areas of application.
Methodological skills: Knowledge of the opportunities, the benefits, and the limits of the use of visualization techniques, detection of errors in visualization solutions.

Content

- Fundamentals: human-computer interaction (HCI), perception and cognition, gestalt laws, color models, data representation
- Scalar data: charts (e.g., line charts, bar charts, scatter plots, histograms), color coding, contour lines, multi-variate data
- Volume data: isosurfaces, volume rendering, ray casting
- Vector fields: glyphs, flow lines, flow paths Relations: visualization of hierarchies (trees) and networks (graphs), e.g., tree map, force-directed layout
- Software: Current visualization libraries and graphical development environments, application to real data

Requirements for Contact Hours

Active participation, solving exercise problems, project work

Requirements for Independent Study Hours

Preparation and review of the lectures, reading literature

Bibliography

Lecture notes
Telea, A.C.: Data Visualization, CRC Press
Munzner, T.: Visualization Analysis & Design, CRC Press
Ward, M., Grinstein, G.G., Keim, D.: Interactive Data Visualization. CRC Press
Ware, C.: Information Visualization. Morgan Kaufmann

Module MIN-304 Algorithms and Complexity

Subheading	(MIN-AK)
Level of Module	Basic module
Type of Module	Compulsory module
Submodules	MIN-304-01 Algorithms and Complexity, Compulsory
Person in Charge	Ginkel, Ingo, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	Theoretical Computer Science (BIN-104), Algorithms and Datastructures (BIN-109)
Examination	Written or oral exam, experimental work

Learning Outcomes

Theoretical and mathematical competences: Characterizing the difficulty of given problems as well as their classification with respect to efficient algorithms and solvability.
Analysis, design and realization competences: Knowledge of different algorithmic strategies for solving practically relevant problems of high complexity (time, memory).
Technological competences: Implementation of these algorithms

Submodule MIN-304-01 Algorithms and Complexity

Subheading	(MIN-AK)
Person in Charge	Ginkel, Ingo, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	3
Suggestions for Independent Study	See literature
Recommended Prerequisites	Theoretical Computer Science (BIN-104), Algorithms and Datastructures (BIN-109)
Examination	Written or oral exam, experimental work

Learning Outcomes

Theoretical and mathematical competences: Characterizing the difficulty of given problems as well as their classification with respect to efficient algorithms and solvability.
Analysis, design and realization competences: Knowledge of different algorithmic strategies for solving practically relevant problems of high complexity (time, memory).
Technological competences: Implementation of these algorithms

Content

Theory: Computability, classes P and NP, NP-completeness, Polynomial reduction, rheorem of Cook-Levin, graph algorithms.
Solution strategies: Divide and conquer (master theorem), backtracking, branch-and-bound, local improvement (greedy), linear
programming, genetic algorithms, simulated annealing, randomization, bin-packing
Problems: Max-Cut problem, traveling salesman problem, knapsack, Euler circles, minimum spanning tree, etc.

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, group work, theoretical and practical exercises.

Bibliography

lecture slides
Hromkovic: Algorithmics for Hard Problems: Introduction to Combinatorial Optimization, Randomization, Approximation, and Heuristics, Springer 2004
Wegener: Komplexitätstheorie - Grenzen der Effizienz von Algorithmen. Springer, 2003

Module MIN-305 Seminar

Subheading	(MIN-MSEM)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-305-01 Seminar, Compulsory
Person in Charge	Wohlfeil, Stefan, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	34 h / 146 h
Semester	2
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	All modules of semester 1
Examination	Term paper, presentation, compulsory attendance

Learning Outcomes

Specialist skills: In the seminar, students delve deeper into the contents of the previous courses using different examples and expand their analytical skills by dealing with new topics that are currently under research/development. Because these topics can also come from related fields, students will also expand their interdisciplinary skills.
Methodological skills: Students expand their knowledge in working independently with challenging scientific literature.?Social and personal skills: Students learn to present scientific contexts
convincingly both verbally and in writing. Discussions provide an opportunity to practice critical reflection. Project management skills and the willingness to learn as well as to perform are trained since the students are obliged to adhere to deadlines using only limited resources.

Submodule MIN-305-01 Seminar

Subheading	(MIN-MSEM)
Person in Charge	Wohlfeil, Stefan, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Seminar, 2 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	34 h / 146 h
Suggestions for Independent Study	Depends on the individual topic of the student
Recommended Prerequisites	All modules of semester 1
Examination	Term paper, presentation, compulsory attendance

Learning Outcomes

Specialist skills: In the seminar, students delve deeper into the contents of the previous courses using different examples and expand their analytical skills by dealing with new topics that are currently under research/development. Because these topics can also come from related fields, students will also expand their interdisciplinary skills.
Methodological skills: Students expand their knowledge in working independently with challenging scientific literature.?Social and personal skills: Students learn to present scientific contexts
convincingly both verbally and in writing. Discussions provide an opportunity to practice critical reflection. Project management skills and the willingness to learn as well as to perform are trained since the students are obliged to adhere to deadlines using only limited resources.

Content

Participants deal independently with a demanding scientific topic, prepare a written report and present their findings, using scientific methods and techniques.

Requirements for Contact Hours

Give presentation about assigned topic. Listen to all other presentations. Ask questions and participate in discussions. (compulsory attendance)

Requirements for Independent Study Hours

Search literature about assigned topic using the library and the Digital Libraries of ACM and/or IEEE. Prepare a presentation about the topic and write a paper (report) about it.

Bibliography

To be announced by the lecturer at the beginning of the course

Module MIN-306 Master Project

Subheading	(MIN-MSPR)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-306-01 Master Project, Compulsory
Person in Charge	Dunkel, Jürgen, Prof. Dr.
ECTS Credits	12
Contact Hours / Independent Study Hours	180 h / 180 h
Semester	3
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	All courses in the student's chosen area of specialization (major), in particular MIN-302 Project and Quality Management (MIN-PMQM)
Examination	experimental work

Learning Outcomes

Analytical skills: Ability to analyze the given problem using scientific methods and findings
Design/realization skills: Ability to develop solution strategies and implementing them
Technological skills: Ability to combine knowledge from different areas and use it for a specific purpose
Methodological skills: Ability to use different innovative methods to solve practical problems
Project management skills: Ability to plan projects, set up an organizational structure and to steer projects to reach the desired goal.
Social skills: Use of conflict-solving strategies

Submodule MIN-306-01 Master Project

Subheading	(MIN-MSPR)
Person in Charge	Dunkel, Jürgen, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Project, 6 SWS
ECTS Credits	12
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	3
Suggestions for Independent Study	see literature
Recommended Prerequisites	none
Examination	experimental work

Learning Outcomes

Analytical skills: Ability to independently analyze the given problem using scientific methods and findings
Analytical skills: Ability to analyze the given problem using scientific methods and findings
Design/realization skills: Ability to develop solution strategies and implement them using the skills acquired
Technological skills: Ability to combine knowledge from different areas and use it for a specific purpose
Methodological skills: Ability to use different innovative methods to solve practical problems
Project management skills: Ability to plan projects, set up an organizational structure and to steer projects to reach the desired goal. Risk management
Social skills: Use of conflict-solving strategies

Content

The Master project focuses on dealing with a complex, current problem from the field of computer science; it may originate from one of the areas of specialization (majors). The task is characterized by independent teamwork on the project with project-specific organization, planning and execution. The concrete contents, processes and methods are derived from the problem at hand.

Requirements for Contact Hours

active involvement in the project, also taking organizational roles

Requirements for Independent Study Hours

implementation of specific project tasks: e.g. design, programming, testing, documentation

Bibliography

project specifi

Module MIN-307 Master Thesis

Subheading	(MIN-MA)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-307-01 Master Thesis, Compulsory
Person in Charge	Wohlfeil, Stefan, Prof. Dr.
ECTS Credits	30
Contact Hours / Independent Study Hours	90 h / 810 h
Semester	4
Duration of Module	1 semester
Prerequisites	Master Thesis is the final examination and can only be passed after all other examinations have been passed successfully.
Recommended Prerequisites	All modules of semesters 1 to 3
Examination	Term paper, presentation, compulsory attendance

Learning Outcomes

Ability to work through a complex, practical topic from the field of computer science independently using scientific methods, i.e. analyzing the problem, finding solution approaches, classifying these in the state- of-the-art science/technology and perhaps implementing and finally evaluating them
Ability to write a sophisticated scientific treatise on the chosen topic. In the colloquium, students show that they are able to present complex information in a short time to an audience of other specialists in this field in an understandable way.

Submodule MIN-307-01 Master Thesis

Subheading	(MIN-MA)
Person in Charge	Wohlfeil, Stefan, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Final Thesis, NaN SWS
ECTS Credits	30
Contact Hours / Independent Study Hours	90 h / 810 h
Suggestions for Independent Study	Depends on the chosen topic
Recommended Prerequisites	All modules of semesters 1 to 3
Examination	Written thesis, own presentation and discussion, defense of thesis.

Learning Outcomes

Ability to work through a complex, practical topic from the field of computer science independently using scientific methods, i.e. analyzing the problem, finding solution approaches, classifying these in the state- of-the-art science/technology and perhaps implementing and finally evaluating them
Ability to write a sophisticated scientific treatise on the chosen topic. In the colloquium, students show that they are able to present complex information in a short time to an audience of other specialists in this field in an understandable way.

Content

In contrast to the Bachelor thesis, the Master thesis focuses on a more challenging, perhaps more extensive topic on a higher academic/scientific level over a longer period of time.

Requirements for Contact Hours

Discussions with thesis advisor; Give presentation and be able to defend it during discussion about the topic.

Requirements for Independent Study Hours

Search literature about thesis topic using the library and the Digital Libraries of ACM and/or IEEE. Work on thesis topic and write thesis itself. Prepare a presentation about the thesis.

Bibliography

Dependent on the topic of the thesis; is recommended by the thesis advisor and then independently updated, expanded and supplement by the student.

Module MIN-311 Geometric Modeling

Subheading	(MIN-GM)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-311-01 Geometric Modeling, Compulsory
Person in Charge	Sprengel, Frauke, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	BIN-200 Computer graphics 1 (BIN-CG1) or MDI-200 Computer graphics 1 (MDI-CG1)
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Theoretical and methodological skills: Fundamental knowledge in geometric modeling; understanding of applicable methods and their limits
Analysis, design and realization skills: Ability to formulate, formalize, and solve modeling problems (i.e., implement appropriate algorithms)

Submodule MIN-311-01 Geometric Modeling

Subheading	(MIN-GM)
Person in Charge	Sprengel, Frauke, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	see literature
Recommended Prerequisites	BIN-200 Computer graphics 1 (BIN-CG1) or MDI-200 Computer graphics 1 (MDI-CG1)
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Theoretical and methodological skills: Fundamental knowledge in geometric modeling; understanding of applicable methods and their limits
Analysis, design and realization skills: Ability to formulate, formalize, and solve modeling problems (i.e., implement appropriate algorithms)

Content

Free-form curves and surfaces (Bézier, B-splines, NURBS), subdivision surfaces, solid modeling (constructive solid geometry), geometric continuity, interpolation, approximation

Requirements for Contact Hours

Active participation, individual task-solving in small groups, discussion

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature, individual or group task-solving, individual discussion

Bibliography

Lecture notes
G. Farin: Curves and Surfaces in CAGD, latest edition
C. de Boor. A Practical Guide to Splines. Springer, Heidelberg 1987
H. Prautzsch: Bézier and B-Spline Techniques, Springer 2002

Module MIN-312 Computer Graphics and Interaction

Subheading	(MIN-CGI)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-312-01 Computer Graphics and Interaction, Compulsory
Person in Charge	Ahlers, Volker, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	Bachelor level computer graphics lecture, e.g., BIN-200 Generative Computer Graphics (BIN-CG1) or MDI-200 (MDI-CG1)
Examination	Written or oral examination, experimental work

Learning Outcomes

Algorithmic skills: Understanding of mathematical and algorithmic fundamentals of computer graphics, in particular real-time rendering as well as virtual and augmented reality.
Analysis, design and realization skills: Design and realization of interactive graphics applications with current graphics libraries, design and realization of natural user interfaces.
Technological skills: Understanding of the function of modern graphics processors, knowledge of the use of computer graphics in different areas of application.
Methodological skills: Knowledge of the possibilities, the benefits, and the limits of using techniques of computer graphics as well as virtual and augmented reality.

Submodule MIN-312-01 Computer Graphics and Interaction

Subheading	(MIN-CGI)
Person in Charge	Ahlers, Volker, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	see literature
Recommended Prerequisites	Bachelor level computer graphics lecture, e.g., BIN-200 Generative Computer Graphics (BIN-CG1) or MDI-200 (MDI-CG1)
Examination	Written or oral examination, experimental work

Learning Outcomes

Algorithmic skills: Understanding of mathematical and algorithmic fundamentals of computer graphics, in particular real-time rendering as well as virtual and augmented reality.
Analysis, design and realization skills: Design and realization of interactive graphics applications with current graphics libraries, design and realization of natural user interfaces.
Technological skills: Understanding of the function of modern graphics processors, knowledge of the use of computer graphics in different areas of application.
Methodological skills: Knowledge of the possibilities, the benefits, and the limits of using techniques of computer graphics as well as virtual and augmented reality.

Content

- Fundamentals: real-time rendering, architecture of modern graphics processors, rendering pipeline, programmable shaders, concepts of virtual and augmented reality
- Advanced rendering techniques: mirroring, shadows, image-based rendering, particle systems, collision detection
- Modeling: scene graphs, spatial data structures
- Interaction: natural user interfaces, stereo rendering, motion tracking, peripheral device interfaces
- Software: current graphics, scene graph, and VR libraries. applications of computer graphics

Requirements for Contact Hours

Active participation, solving exercise problems, project work

Requirements for Independent Study Hours

Preparation and review of the lectures, reading literature

Bibliography

Lecture Notes
Akenine-Möller, T., Haines, E., Hoffman, N.: Real-Time Rendering, CRC Press
Nischwitz, A., Fischer, M., Haberäcker, P., Socher, G.: Computergrafik und Bildverarbeitung, Band 1, Vieweg +Teubner

Module MIN-313 Visual Computing

Subheading	(MIN-VC)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-313-01 Visual Computing, Compulsory
Person in Charge	Sprengel, Frauke, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	Basic knowledge of digital image processing and computer graphics
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Technological skills: Profound knowledge in a selected field of visual computing; understanding of applicable methods and their limits
Methodological skills: Application of innovative methods in the selected field of work
Analysis, design and realization skills: Ability to formulate, formalize, and solve problems in a new and developing field of computer graphics, computer vision, and visualization

Submodule MIN-313-01 Visual Computing

Subheading	(MIN-VC)
Person in Charge	Sprengel, Frauke, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	see literature
Recommended Prerequisites	Basic knowledge of digital image processing and computer graphics
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Technological skills: Profound knowledge in a selected field of visual computing; understanding of applicable methods and their limits
Methodological skills: Application of innovative methods in the selected field of work
Analysis, design and realization skills: Ability to formulate, formalize, and solve problems in a new and developing field of computer graphics, computer vision, and visualization

Content

A selected topic of visual computing is introduced, e.g., medical visualization, digital image creation, pattern recognition and machine learning, artificial intelligence, robotics, GPU computing, image databases, finding events in image sequences, modeling and simulation.
First and foremost current topics and developments shall be considered. Research-oriented problems may lay the foundation of the master thesis.

Requirements for Contact Hours

Active participation, individual task-solving in small groups, discussion

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature, individual or group task-solving, individual discussion

Bibliography

Lecture notes
Current literature according to contents

Module MIN-314 Computational Geometry

Subheading	(MIN-COG)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-314-01 Computational Geometry, Compulsory
Person in Charge	Ginkel, Ingo, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	MIN-311 Geometric Modelling (MIN-GM) , MIN-312 Computer Graphics and Interaction(MIN-CGI)
Examination	Written or oral exam, experimental work

Learning Outcomes

Theoretical and mathematical competences: Characterizing the difficulty of given geometric problems as well as their classification with respect to efficient algorithms and solvability. Analysis, design and realization competences: Knowledge of different algorithmic strategies for solving practically relevant geometric problems. Technological competences: Implementation of these algorithms

Submodule MIN-314-01 Computational Geometry

Subheading	(MIN-COG)
Person in Charge	Ginkel, Ingo, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	MIN-311 Geometric Modelling (MIN-GM) , MIN-312 Computer Graphics and Interaction(MIN-CGI)
Examination	Written or oral exam, experimental work

Learning Outcomes

Theoretical and mathematical competences: Characterizing the difficulty of given geometric problems as well as their classification with respect to efficient algorithms and solvability. Analysis, design and realization competences: Knowledge of different algorithmic strategies for solving practically relevant geometric problems. Technological competences: Implementation of these algorithms

Content

Selected topics in the field of computational
geometry, e.g. art gallery problem, polygon triangulation,
Voronoi diagrams, Delaunay triangulation, windowing, point location, efficient collision detection and -avoidance, spacial data structures like like Octrees or kd-Trees, robot motion planning,
graph theory and algorithms, point-based graphics, geometric filtering, etc.

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature, implementing algorithms

Bibliography

De Berg: Computational Geometry, Springer 2008, further literature based on varying topics

Module MIN-315 Computer Vision

Subheading	(MIN-CV)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-315-01 Computer Vision, Compulsory
Person in Charge	Pigors, Adrian, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	None
Recommended Prerequisites	Basic principles of digital image processing as in BIN-207 (BIN-CG2) or MDI-210 (MDI-CG2)
Examination	Written or oral examination, experimental work

Learning Outcomes

Algorithmic and mathematical skills: profound knowledge and understanding of the mathematical and algorithmic principles of digital image processing.
Analysis and design skills: being able to solve unusually or incompletely defined image analysis problems in different application scenarios.
Technological skills: combined knowledge from image processing, mathematics and computer science; being able to recognize the limitations of image analysis techniques.

Submodule MIN-315-01 Computer Vision

Subheading	(MIN-CV)
Person in Charge	Pigors, Adrian, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	Basic principles of digital image processing as in BIN-207 (BIN-CG2) or MDI-210 (MDI-CG2)
Examination	Written or oral examination, experimental work

Learning Outcomes

Algorithmic and mathematical skills: profound knowledge and understanding of the mathematical and algorithmic principles of digital image processing.
Analysis and design skills: being able to solve unusually or incompletely defined image analysis problems in different application scenarios.
Technological skills: combined knowledge from image processing, mathematics and computer science; being able to recognize the limitations of image analysis techniques.

Content

In-depth knowledge of methods for recognizing and extracting logically connected image contents in images or image sequences as well as their description at a higher level of abstraction, in order to recognize, for example, depicted objects:
- segmentation methods
- representation and description of segments
- object recognition
- characterization and comparison of similar images.

Requirements for Contact Hours

Participating actively, solving exercise problems

Requirements for Independent Study Hours

Preparing and following up lectures, solving exercise problems, discussing material

Bibliography

Lecture notes
Gonzalez, R. C., Woods, R. E.: Digital Image Processing, Prentice Hall
Jähne, B.: Digitale Bildverarbeitung, Springer
Baggio, Escriva, Mahmood et al.: Mastering OpenCV with Practical Computer Vision Projects, Packt

Module MIN-321 IT Security I

Subheading	MIN-ITS1
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-321-01 IT Security I, Compulsory
Person in Charge	Wohlfeil, Stefan, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	BIN-112 Operating Systems and Networks 1 (BIN-BSN1) BIN-202 Operating Systems and Networks 2 (BIN-BSN2)
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Technological skills: Students have acquired sound, in-depth knowledge of security measures and mechanisms. They are able to combine knowledge from the fields of mathematics, computer networks and IT security and handle the level of complexity involved. They know the principles of the most important security technologies and are able to expand and delve deeper into these subjects independently.
Design and realization skills: Students are able to solve unusual, incompletely defined problems from the field of IT security and also implement the solutions technically.
Social skills: In the exercises, students acquire the skills to act independently (familiarization, analysis, concept and implementation) as well as in cooperation with teams.

Submodule MIN-321-01 IT Security I

Subheading	(MIN-ITS1)
Person in Charge	Wohlfeil, Stefan, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	BIN-112 Operating Systems and Networks 1 (BIN-BSN1) BIN-202 Operating Systems and Networks 2 (BIN-BSN2)
Examination	Written or oral exam, experimental work

Learning Outcomes

Technological skills: Students have acquired sound, in-depth knowledge of security measures and mechanisms. They are able to combine knowledge from the fields of mathematics, computer networks and IT security and handle the level of complexity involved. They know the principles of the most important security technologies and are able to expand and delve deeper into these subjects independently.
Design and realization skills: Students are able to solve unusual, incompletely defined problems from the field of IT security and also implement the solutions technically.
Social skills: In the exercises, students acquire the skills to act independently (familiarization, analysis, concept and implementation) as well as in cooperation with teams.

Content

Terminology: Threats, risks, weaknesses, protection goal. Security Technologies: Authentication, Authorization, Identiy Management, Cryptography; Hash functions; message authentication codes; digital signatures; X.509 certificates; use of security technologies for e-mail (PGP and S/MIME), surfing (SSL), remote log-in (SSH); Kerberos; security standards and processes; forensics; web security

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature

Bibliography

Lecture notes
C. Eckert: IT Sicherheit. Konzepte, Verfahren, Protokolle; Oldenbourg
C. Kaufman, R. Perlman, M. Speciner: Network Security - Private Communication in a PUBLIC World; Prentice Hall
W. Stallings: Cryptography and Network Security; Prentice Hall
S. Wohlfeil: Kurs 01866 - Sicherheit im Internet, FernUniversität Hagen

Module MIN-322 IT Security II

Subheading	(MIN-ITS2)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-322-01 IT Security II, Compulsory
Person in Charge	Wohlfeil, Stefan, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	MIN-321
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Technological skills: Students have acquired sound, in-depth knowledge of security measures and mechanisms. They are able to combine knowledge from the fields of mathematics, computer networks and IT security and handle the level of complexity involved. They know the principles of the most important security technologies and are able to expand and delve deeper into these subjects independently.
Design and realization skills: Students are able to solve unusual, incompletely defined problems from the field of IT security and also implement the solutions technically.
Social skills: In the exercises, students acquire the skills to act independently (familiarization, analysis, concept and implementation) as well as in cooperation with teams.

Submodule MIN-322-01 IT Security II

Subheading	(MIN-ITS2)
Person in Charge	Wohlfeil, Stefan, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	MIN-321 IT Security 1 (MIN-ITS1)
Examination	Written or oral exam, experimental work

Learning Outcomes

Technological skills: Students have acquired sound, in-depth knowledge of security measures and mechanisms. They are able to combine knowledge from the fields of mathematics, computer networks and IT security and handle the level of complexity involved. They know the principles of the most important security technologies and are able to expand and delve deeper into these subjects independently.
Design and realization skills: Students are able to solve unusual, incompletely defined problems from the field of IT security and also implement the solutions technically.
Social skills: In the exercises, students acquire the skills to act independently (familiarization, analysis, concept and implementation) as well as in cooperation with teams.

Content

Security in e-commerce, secure methods of payment; biometry; anonymity and privacy (mixes); intrusion detection (principles and network-based as well as host-based systems); Virtual Private Networks (how they work, characteristics, technologies, such as layer 2 vs. layer 3, systems like IPSEC, OpenVPN), security architectures, development of secure systems; Firewalls (Architectures, packet filters ALG, DMZ, etc.); Virtualization

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature

Bibliography

Lecture notes
S. Northcutt, J. Novak: Network Intrusion Detection; New Riders
J. Snader: VPNs Illustrated; Addison-Wesley
S. Wohlfeil: Kurs 01867 - Sicherheit im Internet 2; FernUniversität Hagen

Module MIN-323 Advanced Topics in IT Security

Subheading	(MIN-SSI)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-323-01 Advanced Topics in IT Security, Compulsory
Person in Charge	Hovestadt, Matthias, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	MIN-321 IT Security I (MIN-ITS1), MIN-322 IT Security II (MIN-ITS2)
Examination	Written or oral examination, experimental work

Learning Outcomes

Technological skills: Students have advanced knowledge on a special topic of IT security. Students have knowledge on applicable technologies and their limitations.
Design, implementation and methodic skills: Students are able to apply innovative methods of the focused domain.
Comprehensive: Students are able to transfer theoretical knowledge and comprehend complex contexts.

Submodule MIN-323-01 Advanced Topics in IT Security

Subheading	(MIN-SSI)
Person in Charge	Hovestadt, Matthias, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	The listed literature is intended as an entry point only. It is highly recommended to look into literature beyond the listed books, e.g. using the university library. Since highly topical issues are addressed, the notion of literature does not only imply books but particularly also journals and research papers.
Recommended Prerequisites	MIN-321 IT Security I (MIN-ITS1), MIN-322 IT Security II (MIN-ITS2)
Examination	Written or oral examination, experimental work

Learning Outcomes

Technological skills: Students have advanced knowledge on a special topic of IT security. Students have knowledge on applicable technologies and their limitations.
Design, implementation and methodic skills: Students are able to apply innovative methods of the focused domain.
Comprehensive: Students are able to transfer theoretical knowledge and comprehend complex contexts.

Content

Selected topical issues from IT security, e.g. trusted computing, cryptography, development of secure software, security assessment, security evaluation and security management, threats and risks, penetration testing

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature, practical evaluation of theoretical concepts

Bibliography

Depending on the specific topic

Module MIN-324 Secure Software Engineering

Subheading	(MIN-SSE)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-324-01 Secure Software Engineering, Compulsory
Person in Charge	Peine, Holger, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	MIN-321 IT Security 1 (MIN-ITS1)
Examination	Examination (written or oral) and experimental work

Learning Outcomes

Analytical and technological skills: Students can recognize the most important types of security vulnerabilities in is real software and assess their damage potential
Design, implementation and methodic skills: Students master techniques and methods for various activities to avoid or detect vulnerabilities in the software development process

Submodule MIN-324-01 Secure Software Engineering

Subheading	(MIN-SSE)
Person in Charge	Peine, Holger, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	MIN-321 IT Security 1 (MIN-ITS1)
Examination	Examination (written or oral) and experimental work

Learning Outcomes

Analytical and technological skills: Students can recognize the most important types of security vulnerabilities in is real software and assess their damage potential
Design, implementation and methodic skills: Students master techniques and methods for various activities to avoid or detect vulnerabilities in the software development process

Content

- Types of security vulnerabilities in software and their causes
- Eliciting and stating security requirements
- Finding, ranking and preventing security threats
- Security in software architecture
- Secure coding
- Testing and inspections for security vulnerabilities
- Secure user interfaces and process models for secure software

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature

Bibliography

- Michael Howard, David LeBlanc: Writing Secure Code, 2nd ed. 2003
- Gary McGraw: Software Security - Building Security In, 2006
- John Viega, Gary McGraw: Building Secure Software, 2001
- Michael Howard, Steve Lipner: The Security Development Lifecycle, 2006

Module MIN-331 Database Paradigms

Subheading	(MIN-DBP)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-331-01 Database Paradigms, Compulsory
Person in Charge	Heine, Felix, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	None
Recommended Prerequisites	None
Examination	Written or oral examination, experimental work

Learning Outcomes

Analysis and design skills: Recognize usage scenarios for alternative DB paradigms; ability to select the correct model / system for a given problem. Design of applications based on alternative DB paradigms
Algorithmic skills: Knowledge of modern DB algorithms, especially memory organization and query processing. Knowledge of the pros and cons of the algorithms for a given problem.
Technological skills: Knowledge of query languages and access APIs.

Submodule MIN-331-01 Database Paradigms

Subheading	(MIN-DBP)
Person in Charge	Heine, Felix, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	None
Examination	Written or oral examination, experimental work

Learning Outcomes

Analysis and design skills: Recognize usage scenarios for alternative DB paradigms; ability to select the correct model / system for a given problem. Design of applications based on alternative DB paradigms
Algorithmic skills: Knowledge of modern DB algorithms, especially memory organization and query processing. Knowledge of the pros and cons of the algorithms for a given problem.
Technological skills: Knowledge of query languages and access APIs.

Content

This module focuses on alternatives to relational databases and advanced extensions for relational databases. The module contains topics ranging from data modeling, query languages up to implementation details like query processing. It optionally includes application programming using alternative DB paradigms. Specific topics might include:

- Object-relational and object-oriented databases
- XML databases and query languages
- Graph databases
- Key/value databases
- Document databases
- Column-oriented storage of data
- In-memory databases
- Embedded databases

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing

Bibliography

Edlich, Friedland, Hampe, Brauer: N*SQL. Einstieg in die Welt Nichtrelationaler Web 2.0 Datenbanken, Hanser, 2011
Dietrich, Urban: An Advanced Course in Database Systems: Beyond Relational Databases, Prentice Hall, 2005
Sadalage, Fowler: NoSQL Distilled, Pearson, 2012
Additional material according to latest lecture contents.

Module MIN-332 Distributed Information Systems

Subheading	(MIN-VIS)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-332-01 Distributed Information Systems, Compulsory
Person in Charge	Koschel, Arne, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	Completed Bachelor studies with computer science contents at least comparable to BIN modules in Programming, Information Systems and operating Systems and Networks
Examination	Written or oral exam, experimental work

Learning Outcomes

Analysis and design skills: Evaluate, design and implement information systems with respect to given criteria; select and apply patterns.
Algorithmic skills: Understand and apply distributed algorithms.
Technological skills: Knowledge of concepts and technologies for the implementation, operation and usage of distributed information systems; review required aspects of distributed information systems in the context of different architecture models.

Submodule MIN-332-01 Distributed Information Systems

Subheading	(MIN-VIS)
Person in Charge	Koschel, Arne, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	Completed Bachelor studies with computer science contents at least comparable to BIN modules in Programming, Information Systems and operating Systems and Networks
Examination	Written or oral exam, experimental work

Learning Outcomes

Analysis and design skills: Evaluate, design and implement information systems with respect to given criteria; select and apply patterns.
Algorithmic skills: Understand and apply distributed algorithms.
Technological skills: Knowledge of concepts and technologies for the implementation, operation and usage of distributed information systems; review required aspects of distributed information systems in the context of different architecture models.

Content

In this module advanced skills for the implementation and operation of distributed information systems are taught. For this end core requirements of distributed information systems will be presented and methods to fulfill these requirements will be introduced. Theoretical concepts are learnt and applied in the context of existing software systems. Important aspects include:

- Distributed relational DBMS
- Parallelization aspects (scalability, load balancing, partitioning, replication, consistency, advanced transaction concepts, ...);
- Distributed file systems
- Patterns for distributed information systems, e.g., map reduce, ...
- Distributed data analytics algorithns, e.g., k-means, cluster, pagerank, ...
- Potentially selected additional topics and current research.

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature

Bibliography

Conrad, S., Hasselbring, W., Koschel, A., Tritsch. R.: Enterprise Application Integration, Spektrum/Elsevier.
Dunkel, J., Eberhart, A., Fischer, S., Kleiner, C., Koschel, A.Systemarchitekturen für verteilte Anwendungen, Hanser.
Further literature according to concrete contents.

Module MIN-333 Data Analytics

Subheading	(MIN-DA)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-333-01 Data Analytics, Compulsory
Person in Charge	Heine, Felix, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	None
Recommended Prerequisites	None
Examination	Written or oral examination, experimental work

Learning Outcomes

Analysis and design skills: Knowledge of methods to locate and analyze data. Ability to choose the right method or the right combination of methods for a given problem. Understand the architecture of a Data Warehouse.
Algorithmic skills: Understand algorithms for data analytics. Knowledge of prerequisites, application areas and pros and cons.
Technological skills: Knowledge of example systems (e.g. Rapid-Miner).

Submodule MIN-333-01 Data Analytics

Subheading	(MIN-DA)
Person in Charge	Heine, Felix, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	None
Examination	Written or oral examination, experimental work

Learning Outcomes

Analysis and design skills: Knowledge of methods to locate and analyze data. Ability to choose the right method or the right combination of methods for a given problem. Understand the architecture of a Data Warehouse.
Algorithmic skills: Understand algorithms for data analytics. Knowledge of prerequisites, application areas and pros and cons.
Technological skills: Knowledge of example systems (e.g. RapidMiner).

Content

The lecture focuses on various approaches to the organization and analytics of large data sets. The following topics might be covered:
- Data Warehousing
- Data Mining
- Data Quality Based on exemplary systems such as MS SQL Server, RapidMiner, etc. the methods are used in practice in the exercises.

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing

Bibliography

Bauer, Günzel: Data Warehouse Systeme, dpunkt.verlag, 2013
Tan, Steinbach, Kumar: Introduction to Data Mining, Pearson India, 2016
Additional material according to latest lecture contents.

Module MIN-334 Geographical and Multimedia Information Systems

Subheading	(MIN-GMI)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-334-01 Geographical and Multimedia Information Systems, Compulsory
Person in Charge	Kleiner, Carsten, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Semester	3
Duration of Module	1 semester
Prerequisites	None
Recommended Prerequisites	BIN-106 (BIN-DBS1) or MDI-107 (MDI-DBS1), BIN-109 (BIN-AD) or MDI-202 (MDI-AD), BIN-214 (BIN-DBS3) or MDI-222 (MDI-DBS3), MIN-331 (MIN-DBP)
Examination	Written or oral examination, experimental work

Learning Outcomes

Analysis, design and implementation skills: Knowledge about and assessment of strengths and weaknesses of different options for persistent storage of two- and three-dimensional data; knowledge about and assessment and comparison of modeling and querying of geographic and multimedia data; selection and implementation of optimal persistent storage option in particular application scenario
Algorithmical skills: Understand, assess and implement different algorithms for efficient indexing of spatial data, assessment and implementation of different algorithms for text information retrieval and similarity comparison of multimedia data, assessment of their efficiency and applicability
Technological skills: Master and implement/use storage and querying of spatial data in different data models and systems (Oracle Spatial, PostGIS, NoSQL systems); master and implement storage and querying of mutlimedia data in different database systems (Oracle, PostgreSQL)

Submodule MIN-334-01 Geographical and Multimedia Information Systems

Subheading	(MIN-GMI)
Person in Charge	Kleiner, Carsten, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	Work on slides and literature, reflection and self-contained application of content
Recommended Prerequisites	BIN-106 (BIN-DBS1) or MDI-107 (MDI-DBS1), BIN-109 (BIN-AD) or MDI-202 (MDI-AD), BIN-214 (BIN-DBS3) or MDI-222 (MDI-DBS3), MIN-331 (MIN-DBP)
Examination	Written or oral examination, experimental work

Learning Outcomes

Analysis, design and implementation skills: Knowledge about and assessment of strengths and weaknesses of different options for persistent storage of two- and three-dimensional data; knowledge about and assessment and comparison of modeling and querying of geographic and multimedia data; selection and implementation of optimal persistent storage option in particular application scenario
Algorithmical skills: Understand, assess and implement different algorithms for efficient indexing of spatial data, assessment and implementation of different algorithms for text information retrieval and similarity comparison of multimedia data, assessment of their efficiency and applicability
Technological skills: Master and implement/use storage and querying of spatial data in different data models and systems (Oracle Spatial, PostGIS, NoSQL systems); master and implement storage and querying of mutlimedia data in different database systems (Oracle, PostgreSQL)

Content

Foundation of geo information systems, datatypes and storage of spatial data in database and information systems (of different paradigms), algorithms for text analysis, algorithms for text information retrieval, applications of information retrieval, foundations of multimedia information systems, similarity search on multimedia documents and corresponding algorithms, typical query types for multimedia data

Requirements for Contact Hours

Lecture: Following presentations and examples, discussion, following executions and visualizations in learning software, reflection of content, self-contained application of subjects
Exercise: Self-contained work on problems on paper and by using learning software, theoretical problems, presentation of problem solutions and project results

Requirements for Independent Study Hours

Preparation and post-processing of lectures and exercises, self-contained work on problems, turning in homework in small groups, self-contained work on a project task in small groups, exam preparation, reading literature

Bibliography

de Berg, van Kreveld, Overmars: Computational Geometry, Springer
Rigaux, Scholl, Voissard: Spatial Databases with application to GIS, Morgan Kaufmann
T. Brinkhoff: Geodatenbanksysteme in Theorie und Praxis, Wichmann
Ingo Schmitt: Ähnlichkeitssuche in Multimedia-Datenbanken, Oldenburg-Verlag
R. Baeza-Yates, B. Ribeiro-Neto: Modern Information Retrieval, Addison-Wesley, 2010, ISBN 0321416910

Module MIN-324 Secure Software Engineering

Subheading	(MIN-SSE)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-324-01 Secure Software Engineering, Compulsory
Person in Charge	Peine, Holger, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	MIN-321 IT Security 1 (MIN-ITS1)
Examination	Examination (written or oral) and experimental work

Learning Outcomes

Analytical and technological skills: Students can recognize the most important types of security vulnerabilities in is real software and assess their damage potential
Design, implementation and methodic skills: Students master techniques and methods for various activities to avoid or detect vulnerabilities in the software development process

Submodule MIN-324-01 Secure Software Engineering

Subheading	(MIN-SSE)
Person in Charge	Peine, Holger, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	MIN-321 IT Security 1 (MIN-ITS1)
Examination	Examination (written or oral) and experimental work

Learning Outcomes

Analytical and technological skills: Students can recognize the most important types of security vulnerabilities in is real software and assess their damage potential
Design, implementation and methodic skills: Students master techniques and methods for various activities to avoid or detect vulnerabilities in the software development process

Content

- Types of security vulnerabilities in software and their causes
- Eliciting and stating security requirements
- Finding, ranking and preventing security threats
- Security in software architecture
- Secure coding
- Testing and inspections for security vulnerabilities
- Secure user interfaces and process models for secure software

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature

Bibliography

- Michael Howard, David LeBlanc: Writing Secure Code, 2nd ed. 2003
- Gary McGraw: Software Security - Building Security In, 2006
- John Viega, Gary McGraw: Building Secure Software, 2001
- Michael Howard, Steve Lipner: The Security Development Lifecycle, 2006

Module MIN-341 Programming Paradigms

Subheading	(MIN-PPD)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-341-01 Programming Paradigms, Compulsory
Person in Charge	Peine, Holger, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	BIN-102 Introduction to Programming (BIN-PR1) or MDI-102 Introduction to Programming (MDI-102), BIN-108 Object-oriented Programming (BIN-PR2) or MDI-109 Object-oriented Programming (MDI-109)
Examination	Written or oral exam, experimental work

Learning Outcomes

Analytical and technological skills: Classify and assess the expressive means of programming languages
Design, implementation and methodic skills: Extended problem solving capabilities by mastering alternative approaches to thinking, deepen the understanding of object-oriented programming
Technological skills: Learning a functional programming language (e.g. Scala) and (to a limited extent) a logical programming language (e.g. Prolog)

Submodule MIN-341-01 Programming Paradigms

Subheading	(MIN-PPD)
Person in Charge	Peine, Holger, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	BIN-102 Introduction to Programming (BIN-PR1) or MDI-102 Introduction to Programming (MDI-102), BIN-108 Object-oriented Programming (BIN-PR2) or MDI-109 Object-oriented Programming (MDI-109)
Examination	Written or oral exam, experimental work

Learning Outcomes

Analytical and technological skills: Classify and assess the expressive means of programming languages
Design, implementation and methodic skills: Extended problem solving capabilities by mastering alternative approaches to thinking, deepen the understanding of object-oriented programming
Technological skills: Learning a functional programming language (e.g. Scala) and (to a limited extent) a logical programming language (e.g. Prolog)

Content

Programming languages and paradigms (short)
Imperative paradigm (short)
Object-oriented paradigm (medium)
Encapsulation, inheritance: Polymorphism, substitution principle, variance
Functional paradigm (long): Immutability and side effect avoidance, function objects, higher-order functions, closures, lazy evaluation, continuations, functional state.
Logical paradigm (medium): Propositional, predicate and Horn calculus, resolution, unification, negation as failure, procedural semantics

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature

Bibliography

Michael L. Scott: Programming Language Pragmatics
Bertrand Meyer: Object oriented software construction
P. Chiusano, R. Bjarnason: Functional Programming in Scala
Ivan Bratko: PROLOG Programming for Artificial Intelligence.

Module MIN-342 Intelligent Systems

Subheading	(MIN-INS)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-342-01 Intelligent Systems, Compulsory
Person in Charge	Bruns, Ralf, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	MIN-301 (MIN-SWA)
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Technological skills: Acquisition of solid knowledge in the area of Intelligent Systems (Artificial Intelligence), understanding for applicable techniques and methods; assessment of usefulness and limitations of
intelligent technologies
Methods skills: Application and critical assessment of innovative methods in the area Intelligent Systems
Analysis, design and realization skills: Capability to formulate, structure and solve problems of new application domains by means of intelligent software technologies

Submodule MIN-342-01 Intelligent Systems

Subheading	(MIN-INS)
Person in Charge	Bruns, Ralf, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	MIN-301 (MIN-SWA)
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Technological skills: Acquisition of solid knowledge in the area of Intelligent Systems (Artificial Intelligence), understanding for applicable techniques and methods; assessment of usefulness and limitations of
intelligent technologies
Methods skills: Application and critical assessment of innovative methods in the area Intelligent Systems
Analysis, design and realization skills: Capability to formulate, structure and solve problems of new application domains by means of intelligent software technologies

Content

Theoretical foundations and concepts for design and development of intelligent (application) systems, e.g. introduction to Artificial Intelligence, Multi-Agent Systems, inference algorithms, Semantic
Web, Complex Event Processing
In particular, recent research topics will be discussed, with focus on intelligent web and mobile systems. If appropriate, research problems can be further investigated in Master Theses.

Requirements for Contact Hours

Active participation, solving exercises

Requirements for Independent Study Hours

Pre- and post-preparation of the content

Bibliography

According to concrete contents.

Module MIN-343 Advanced Aspects of Distributed Systems

Subheading	(MIN-FAVS)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-343-01 Advanced Aspects of Distributed Systems, Compulsory
Person in Charge	Koschel, Arne, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	Completed Bachelor studies with computer science contents at least comparable to BIN modules in Programming, Information Systems and operating Systems and Networks
Examination	Written or oral exam, experimental work

Learning Outcomes

Analysis and design skills: Assess challenges of different forms of
distributed systems and meet these challenges by means of suitable
methods and technologies; select and apply patterns.
Algorithmic skills: Understand and apply distributed algorithms.
Technological skills: Profound knowledge of challenges, methods and current research results for different approaches to distributed
systems.

Submodule MIN-343-01 Advanced Aspects of Distributed Systems

Subheading	(MIN-FAVS)
Person in Charge	Koschel, Arne, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	See literature
Recommended Prerequisites	Completed Bachelor studies with computer science contents at least comparable to BIN modules in Programming, Information Systems and operating Systems and Networks
Examination	Written or oral exam, experimental work

Learning Outcomes

Analysis and design skills: Assess challenges of different forms of
distributed systems and meet these challenges by means of suitable
methods and technologies; select and apply patterns.
Algorithmic skills: Understand and apply distributed algorithms.
Technological skills: Profound knowledge of challenges, methods and current research results for different approaches to distributed
systems.

Content

In this module advanced skills for the architecture and functionality of different forms of distributed systems are taught. For this end fundamental models of distributed systems are introduced - such as cloud computing, P2P, SOA, Microservices - and characteristic properties of architecture, administration and run-time behavior as well as parallelization and error tolerance are treated. Selected theoretical concepts are realized by means of different software systems. In addition current research results and open problems are studied.

Requirements for Contact Hours

Active participation, solving exercise problems

Requirements for Independent Study Hours

Preparation and postprocessing of the lectures, reading literature

Bibliography

Conrad, S., Hasselbring, W., Koschel, A., Tritsch. R.: Enterprise Application Integration, Spektrum/Elsevier.
Dunkel, J., Eberhart, A., Fischer, S., Kleiner, C., Koschel, A.Systemarchitekturen für verteilte Anwendungen, Hanser.
Tanenbaum, A.: Verteilte Systeme: Prinzipien und Paradigmen, Pearson.
Further literature according to concrete contents.

Module MIN-344 Software Tests and Requirements

Subheading	(MIN-STR)
Level of Module	Specific module
Type of Module	Compulsory module
Submodules	MIN-344-01 Software Tests and Requirements, Compulsory
Person in Charge	Garmann, Robert, Prof. Dr.
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Duration of Module	1 semester
Prerequisites	none
Recommended Prerequisites	Practical experience in all software development phases, esp. in specification and in programming tests. Knowledge of test techniques (e. g. black box / white box) at various test levels (from component tests to acceptance tests)
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Analytical and design skills: knowledge of basic principles and techniques to analyze requirements, ability to utilize that knowledge in a certain requirements domain. Deep insight into all relevant test techniques. Ability to design test cases targeted at a complex system and proving an expected quality. Ability to evaluate a system's quality including domain specific and technical aspects.
Realization skills: The students understand how to realize technical test activities and how to implement necessary tools and techniques to achieve defined test goals.

Submodule MIN-344-01 Software Tests and Requirements

Subheading	(MIN-STR)
Person in Charge	Garmann, Robert, Prof. Dr.
Language of Instruction	by agreement
Curriculum Allocation	MIN
Course Type, Contact Hours per Week	Lecture with exercise, 4 SWS
ECTS Credits	6
Contact Hours / Independent Study Hours	68 h / 112 h
Suggestions for Independent Study	see literature
Recommended Prerequisites	Practical experience in all software development phases, esp. in specification and in programming tests. Knowledge of test techniques (e. g. black box / white box) at various test levels (from component tests to acceptance tests)
Examination	Examination (written or oral examination) and experimental work

Learning Outcomes

Analytical and design skills: knowledge of basic principles and techniques to analyze requirements, ability to utilize that knowledge in a certain requirements domain. Deep insight into all relevant test techniques. Ability to design test cases targeted at a complex system and proving an expected quality. Ability to evaluate a system's quality including domain specific and technical aspects.
Realization skills: The students understand how to realize technical test activities and how to implement necessary tools and techniques to achieve defined test goals.

Content

Requirements: system und system context, requirements elicitation, requirements documentation (using natural language), requirements consolidation, requirements validation and negotiation.
Software test: test process, test techniques (specification-based, structure-based, defect-based, experience-based), testing of software characteristics in domain and technical testing, test tools and test automation.

Requirements for Contact Hours

presentation, discussion, talk about papers

Requirements for Independent Study Hours

independent problem solving, project work

Bibliography

Klaus Pohl, Chris Rupp: Requirements Engineering Fundamentals: A Study Guide for the Certified Professional for Requirements Engineering Exam - Foundation Level - IREB compliant, Rocky Nook (2011)
Andreas Spillner, Tilo Linz, Hans Schaefer: Software Testing Foundations: A Study Guide for the Certified Tester Exam, 3rd ed., Rocky Nook (2011)
Graham Bath, Judy McKay: The Software Test Engineer's Handbook: A Study Guide for the ISTQB Test Analyst and Technical Analyst

Advanced Level Certificates, Rocky Nook (2008)