Module Handbook
Master Informatik / Computer Science (international) (M-IN)

Department 2 - Engineering, Information Technology and Economics

Summer Term 2026

Head of Program: SGL-M-IN Kulesz
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Valid from SS26

Table of Contents

Computer Science

Architektur von Informationssystemen (M-IN-IN02)

Architecture of Information Systems (SYSE) Architektur von Informationssystemen						
Identifier M-IN-IN02	**Workload** 180h	**ECTS** 6	**Term at study start** ST: 2 WT: 1		**Frequency** Wintersemester	**Duration** 1 Semester
1	**Course** Vorlesung Übung		**Contact time lecture** 60h	**Contact time other** 0h	**Self-studies** 120h	**Planned group size** Veranstaltung: 25
2	**Learning outcomes** After successful completion of this module, students acquire the following competencies: - They are aware of additional challenges in the globalization of software development and can software development and can deal with them accordingly. - They can name and describe aspects that can influence motivation and productivity of software developers, including but not limited to psychological aspects - They are familiar with common architecture principles and can validate the validate compliance with design rules. - They have mastered simple DevOps techniques and are able to put software into operation in an automated and reproducible manner. - They can perform user interface testing as well as testing using mocks and mutants and automate these activities. - They are familiar with software maintenance challenges and can deal with them appropriately. - They can select a viable option for operation of large enterprise systems taking into account cloud, co-located and on-premise options. - They can apply Design by Contract to improve the safety of code. - They can monitor applications during test and production operations and propose suitable actions to solve arising issues. - They can evaluate and optimize processes in software-intensive environments.					
3	**Content** The course assumes previous knowledge in basic software engineering concepts and techniques as taught in Computer Science Bachelor programs. Building on this foundation, the course intensifies general understanding and practical actionability in the following areas: - Software Platforms - Cloud Computing - Global Software Engineering - Motivation and Productivity - Architecture Design Process and its Documentation - Architecture Validation, Acceptance Testing - System Introduction - Mock Testing - Mutant Testing and Evaluation of Unit Test Suites - Monitoring and Observability - Distribution, Cloud Computing - Operations - DevOps, Infrastructure as Code - Code Reviews					
4	**Course form** Lecture, Tutorial, Practical Project					
5	**Prerequisites for attending** Formal: none Content: Foundations of Software Engineering					
6	**Form of examination** Schriftliche Klausur Hausarbeit Mündliche Prüfung					

Architecture of Information Systems (SYSE) Architektur von Informationssystemen	
7	**Prerequisites for granting ECTS** bestandene Prüfungsleistung bestandene Studienleistung Notes: Passed exam plus study achievement
8	**Utilization of the module (in other study courses)** This module is not used in other courses.
9	**Weight for the final score** Weighting according to the ECTS points
10	**Module commissioner and lecturers:** **Module commissioner:** SGL-M-IN Kulesz **Lecturers:** SGL-M-IN Kulesz
11	**Further information** **Language:** Englisch **Literature:** - Sommerville, Ian: Software Engineering. Pearson, 10th eds., 2018 - Sadowski, Caitlin, and Thomas Zimmermann: Rethinking productivity in software engineering, Springer Nature, 2019. - Le, D. "Na, Kumar, Rb, Nguyen, GN, Chatterjee, JMd: Cloud Computing and Virtualization, John Wiley and Sons, 2018 - Ludewig, J. und Lichter, H.: Software Engineering - Grundlagen, Menschen, Prozesse Techniken, dpunkt, 4. Auflage, 2023 (German)

Vertiefung Datenbanksysteme (M-IN-IN03)

<table>
<tr><th colspan="6">Advanced Database Systems (VEDA)
Vertiefung Datenbanksysteme</th></tr>
<tr><td>Identifier
M-IN-IN03</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
60h</td><td>Contact time other
30h</td><td>Self-studies
90h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Students know the architecture and structure of relational database systems. They know physical storage and index structures. They understand the issues of multi-user synchronization, serializability even for long-running transactions, and logging and recovery. You understand the 2-phase commit protocol for distributed transactions. They know concepts of distributed database systems as well as for database replication.
Students know the structure and tasks of a data warehouse. They know the meaning of ETL, different approaches to modeling the base database of a DWH (Inmon, Kimball, Data Vault) and the modeling of data cubes and data marts (Star Schema etc.). You are able to design a DWH and to implement its essential components exemplarily. You will be familiar with extended query options for a DWH, in particular using "Analytical SQL", and will be able to apply these in practice.</td></tr>
<tr><td>3</td><td colspan="6">Content
- Layer models of database systems
- Physical storage structures
- Different index structures
- Transaction management and advanced transaction concepts also for distributed databases
- Database replication
- Synchronization, locking procedures and serializability
- Log files and recovery
- Datawarehouse and OLAP: Architecture, Modeling, ETL, Analytical SQL</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture and Tutorials</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: Basics of database systems, especially relational databases</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur
Mündliche Prüfung
the exam form is determined at the beginning of the semester</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Bestandene Modulprüfung</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. rer. nat. Schmidt
Lecturers: Prof. Dr. rer. nat. Schmidt</td></tr>
</table>

Advanced Database Systems (VEDA) Vertiefung Datenbanksysteme	
11	**Further information** **Language:** Englisch **Literature:** - script of the lecture - Kemper, A.: „Datenbanksysteme“ , Oldenbourg, aktuelle Auflage - Garcia-Molina, H..: „Database Systems - The Complete Book, Pearson - Heuer, A: „Datenbanken - Konzepte und Sprachen“, Mitp-Verlag - Heuer, A: „Datenbanken: Implementierungstechniken“, Mitp-Verlag - Hahne, M.:„Modellierung von Business Intelligence-Systemen, dpunkt.verlag - Kemper, H.G.: „Business Intelligence - Grundlagen und praktische Anwendungen", Vieweg+Teubner - Köppen v. et al.: „Data Warehouse Technologien" - Lehner W.: „Datenbanktechnologie für DWH-Systeme", dpunkt.verlag - Bauer A. et al.: „Data Warehouse Systeme", dpunkt.verlag

Systemanalyse (M-IN-IN04)

<table>
<tr><td colspan="7">Systems Analysis (SYSA)
Systemanalyse</td></tr>
<tr><td>Identifier
M-IN-IN04</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
Wintersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
60h</td><td>Contact time other
0h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Students acquire knowledge of model building. They can classify and define systems and determine system boundaries. For the modeling and analysis of systems, students can use methods from different areas of computer science and mathematics.</td></tr>
<tr><td>3</td><td colspan="6">Content
- Systems and models - Model building
- Cellular automata - Learning agents - Chaos theory
- Self-organizing systems
- Game Theory
- Swarm Intelligence
- Stochastic processes and queues</td></tr>
<tr><td>4</td><td colspan="6">Course form
seminaristic lectures and tutorials</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Vortrag
Schriftliche Klausur</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. Mehler
Lecturers: Prof. Dr. Mehler</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
H. Bossel: Systeme, Dynamik, Simulation, Modellbildung. Analyse und Simulation komplexer Systeme, Norderstedt
D. Imboden, S. Koch; Systemanalyse, Einführung in die mathematische Modellierung natürlicher Systeme, Springer-Verlag
J. Schmidt, Ch. Klüver, J. Klüver: Programmierung naturanaloger Verfahren, Vie-weg+Teubner
O. Loistl, Chaostheorie: Zur Theorie nichtlinearer dynamischer Systeme, Oldenbourg-Verlag
Ch. Rieck, Spieltheorie, Eine Einführung, Eschborn
Th. Schickinger, A. Steger, Diskrete Strukturen, Band 2: Wahrscheinlichkeitstheorie und Statistik</td></tr>
</table>

Wissenschaftliches Seminar (M-IN-IN05)

<table>
<tr><td colspan="7">Scientific Course (WISE)
Wissenschaftliches Seminar</td></tr>
<tr><td>Identifier
M-IN-IN05</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
jedes Semester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Seminar</td><td>Contact time lecture
60h</td><td>Contact time other
0h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Students are able to compile the state of the art of a specific research topic in the field of computer science as well as to understand the content of a scientific paper. They are able to formulate a reseach objetctive and puting together a scientifc presentation plus to give a presentation or even a lecture on it. The students have the ability to classify and evaluate a scientific contribution and to differentiate between its significance for research and application. Furthermore, the students have acquired in-depth knowledge and skills for scientific work. The students are able to review and to create a scientific poster.</td></tr>
<tr><td>3</td><td colspan="6">Content
Oranization of science in different contexts (compan, research institute, university). Different opportunities to get funded for research. State based organisation and funding of research. Places to publish and to search professionaly on latest findings in science. Organisation and execution of scientific conferences. Available ways to publish research results and limitations.
Up to date /lates scientific publications from different areas fo Computer Science, like database technologies, cyberscurity, robotics, system architectures, software-engineering, artificial intelligence, operating systems, post-quantum cryptography, web technologies, mobile systems etc.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Seminaristic</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Mündliche Prüfung
Vortrag
presentation in English</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. rer. nat. Marx
Lecturers: Prof. Dr. rer. nat. Marx</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
Current scientific papers of the recent 1-2 years, accepted (blind refree) at sientfic conferences (e.g. published Lecture Notes in Computer Science etc.)</td></tr>
</table>

Künstliche Intelligenz (KI) (M-IN-IN06)

<table>
<tr><td colspan="6">Artificial Intelligence (AI) (ARTI)
Künstliche Intelligenz (KI)</td></tr>
<tr><td>Identifier
M-IN-IN06</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung
Praxisprojekt</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25
Präsenzübung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
The students know advanced methods of artificial intelligence. Especially deep learning and deep reinforcement learning algorithms are understood by the students and can be applied to new problems. The students know how to train, tune and debug Deep Learning models.</td></tr>
<tr><td>3</td><td colspan="6">Content
- Neuronal networks
- Generative adversarial networks
- Attacks against neuronal networks, adversarial examples
- Convolutional neural networks
- Recurrent neural networks
- Reinforcement learning</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture plus workshops</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: keine</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Mündliche Prüfung
Hausarbeit
Vortrag</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Presentation of assignment/project work with positive assessment</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. rer. nat. Marx
Lecturers: Mendoza</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
Stuart Russell, Peter Norvig; Artificial Intelligence: A Modern Approach, 4th Edition (2020)
Ian Goodfellow, Yoshua Bengio, Aaron Courville; Deep Learning (2016)
Richard Sutton, Andrew Barto; Reinforcement Learning: An Introduction (2018)</td></tr>
</table>

Mathematics

Höhere Mathematik (M-IN-MN01)

<table>
<tr><td colspan="6">Higher mathematics for information systems (HÖMA)
Höhere Mathematik</td></tr>
<tr><td>Identifier
M-IN-MN01</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 2
WT: 1</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Students know the basic concepts and algorithms of Operations Research and can apply them for solving real-world optimization problems. Students are able to mathematically model problems relevant to industry and business and solve them using methods of single- and multiobjective (mixed-integer) linear optimization and network optimization. Furthermore, students are familiar with classic application areas of operations research and are able to model and solve optimization problems with the help of mathematical software.</td></tr>
<tr><td>3</td><td colspan="6">Content
- Linear optimization (modeling, standard form, simplex method, duality)
- Integer optimization (modeling, branch-and-bound, knapsack problems)
- Introduction to graph theory (modeling, minimum spanning trees, shortest paths, maximum flows, maximum matchings)
- Multiobjective optimization (modeling, efficiency, dominance, weighted-sum method, epsilon-constraint method, multiobjective shortest paths)</td></tr>
<tr><td>4</td><td colspan="6">Course form
2 SWS lecture and 2 SWS tutorials</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: Mathematik 1, Mathematik 2</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Bestandene Modulprüfung</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. Schäfer
Lecturers: Prof. Dr. Schäfer</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
- Hamacher, H. W., & Klamroth, K. (2000). Lineare und Netzwerk-Optimierung: Ein bilinguales Lehrbuch. A bilingual textbook. Vieweg+ Teubner Verlag.
- Wolsey, L. A., & Nemhauser, G. L. (1999). Integer and combinatorial optimization. John Wiley & Sons.
- Ehrgott, M. (2005). Multicriteria optimization (Vol. 491). Springer Science & Business Media.</td></tr>
</table>

Practice

Masterarbeit mit Kolloquium (M-IN-PP01)

<table>
<tr><th colspan="7">Master Thesis (MAST)
Masterarbeit mit Kolloquium</th></tr>
<tr><td>Identifier
M-IN-PP01</td><td>Workload
900h</td><td>ECTS
30</td><td colspan="2">Term at study start
ST: 3
WT: 3</td><td>Frequency
jedes Semester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Selbststudium und Konsultationen</td><td>Contact time lecture
0h</td><td>Contact time other
0h</td><td>Self-studies
900h</td><td>Planned group size
Veranstaltung: 1</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Students are enabled to independently solve a complex problem or task from science, industry or society.
or society independently and solve them. They are able to assess and evaluate different assess and evaluate different solution approaches. To solve the problem, they apply the technical
knowledge acquired during their studies. Students plan and organize their academic organize their scientific work independently. They can analyze and evaluate scientific sources of information.
be analyzed and evaluated. The results are formulated and presented with scientific precision in the Master's thesis.
In the colloquium, students present their approach, methods and results coherently and logically.</td></tr>
<tr><td>3</td><td colspan="6">Content
The Master thesis is written either at the university or at or in cooperation with a company/institution.
company/institution.
The university lecturer acts as supervisor. He or she supports the students in personal discussions
with regards to compliance with the above-mentioned learning and qualification objectives. Depending on the task, several students can also work on the same project, each of them independently.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Self-study and consultations</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: The requirements are set out in the examination regulations.</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Vortrag
Hausarbeit
Thesis and Presentation/Colloquium (max. 30 minutes)</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed Mater's thesis incl. successfully completed colloquium</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. rer. nat. Marx
Lecturers: Alle Dozenten des Studiengangs Master Informatik / Computer Science (international)</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
Sample master's theses and presentations for the colloquium as well as a list of recommended basic literature are provided on the Internet.</td></tr>
</table>

Wahlpflichtfächer Computer Science

Fortgeschrittenes Projektmanagement (übergreifend) (M-IN-WP01)

<table>
<tr><th colspan="7">Advanced Project Management (comprehensive) (PROJM)
Fortgeschrittenes Projektmanagement (übergreifend)</th></tr>
<tr><td>Identifier
M-IN-WP01</td><td colspan="2">Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung
Praxisprojekt</td><td colspan="2">Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="7">Learning outcomes
Students acquire skills for planning and managing complex projects from science, industry and society. They are familiar with the essential process models and methods, know their specific characteristics and areas of application. They develop the ability to independently plan, organize and manage software development projects. Students will be able to prepare feasibility studies, resource estimates and effort estimates and draw conclusions from them. They will be able to analyze and evaluate risks and safety-related areas for projects. Students develop teamwork skills and the ability to solve problems independently.
Students master the mechanisms of agile project execution and are able to implement and apply them.</td></tr>
<tr><td>3</td><td colspan="7">Content
Students acquire skills for planning and managing complex projects from science, industry and society. They are familiar with the essential process models and methods, know their specific characteristics and areas of application. They develop the ability to independently plan, organize and manage software development projects. Students will be able to prepare feasibility studies, resource estimates and effort estimates and draw conclusions from them. They will be able to analyze and evaluate risks and safety-related areas for projects.
Complexity considerations of large software systems
- Process models of software development (V-model, RUP, Extreme Programming, Scrum etc.) - Application of process models and their specific characteristics,
- Planning techniques and checklists for project planning
- Tools and aids for project management
- Tracking of requirements from analysis to implementation
- Change and configuration management
- Time management and resource management
- Project management standards
- Effort estimation (function point analysis and others)
- Metrics based process management and control.</td></tr>
<tr><td>4</td><td colspan="7">Course form
Seminar</td></tr>
<tr><td>5</td><td colspan="7">Prerequisites for attending
Formal: none
Content: Project management foundations</td></tr>
<tr><td>6</td><td colspan="7">Form of examination
Mündliche Prüfung
Vortrag
Hausarbeit</td></tr>
<tr><td>7</td><td colspan="7">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="7">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="7">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="7">Module commissioner and lecturers:
Module commissioner: Prof. Dr. rer. nat. Marx
Lecturers: Prof. Dr. rer. nat. Marx</td></tr>
</table>

Advanced Project Management (comprehensive) (PROJM) Fortgeschrittenes Projektmanagement (übergreifend)	
11	**Further information** **Language:** Englisch **Literature:** Höhn, Reinhard; Höppner, Stephan, Das V-Modell XT, Grundlagen, Methodik und Anwendungen, Springer, jeweils aktuelle Ausgabe Wolf, Henning, Roock, Stefan, Lippert, Martin, eXtreme Programming: Eine Einführung mit Empfehlungen und Erfahrungen aus der Praxis, Dpunkt, jeweils aktuelle Ausgabe Pichler, Roman, Scrum - Agiles Projektmanagement erfolgreich einsetzen, Dpunkt. jeweils aktuelle Ausgabe, ISBN10 3898644782 Verstegen, Gerhard. Projektmanagement mit dem Rational Unified Process. Springer. Berlin. 2008. Ebel, Nadin. PRINCE2:2009 - für Projektmanagement mit Methode. Addison-Wesley. München. jeweils aktuelle Ausgabe. A Guide to the Project Management Body of Knowledge. Project Management Institute. jeweils aktuelle Ausgabe. Function Point Analyse Poensgen, Benjamin; Bock, Bertram. Die Function-Point-Analyse: Ein Praxishandbuch. dpunkt Verlag. 2005. Hindel, Bernd; Hörmann, Klaus; Müller, Markus; Schmied, Jürgen. Basiswissen Software-Projektmanagement. dpunkt.verlag. jeweils aktuelle Ausgabe

E-Learning (M-IN-WP03)

<table>
<tr><td colspan="7">E-Learning (ELEA)
E-Learning</td></tr>
<tr><td>Identifier
M-IN-WP03</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1,2
WT: 1,2</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
60h</td><td>Contact time other
0h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Knowledge of the various users and roles of an LM system and their requirements of the LM system.
Ability to analyze the requirements and ability to map the requirements to different services and interfaces. Understanding of the interaction of several user groups and roles in an LM system. Integration of services and basic functionalities into role-specific usage scenarios and corresponding usage interfaces. Assessing an LM system from different perspectives: on the one hand, the user perspective (e.g. as a course author who creates a course fragment) and on the other hand, as a system developer who functionally extends the LM system.</td></tr>
<tr><td>3</td><td colspan="6">Content
The tasks and interaction of the various users and roles of a learning management system (LM system) are presented. The roles of the learners, lecturers, tutors, authors and administrators are elaborated. Their different tasks are considered (e.g. course material management, user, rights and cost management, integration of external resources, etc.). The resulting requirements for an LM system are derived.
Services and interfaces of LM systems are considered. Furthermore, the characteristics of different forms of learning as well as norms and standards in the field of LM systems (SCORM, Dublin Core, LMO, ...) are presented. The learning material lifecycle is taught. The theoretical knowledge is deepened/implemented in two small team phases.
On the one hand, the prototypical creation and integration of an e-learning course fragment into an LM system is carried out. This involves planning and creating course materials. These are modularized, provided with metadata and integrated into an LM system.
The development of LM systems is also considered. For this purpose, either a new functionality to be implemented is identified based on a requirements analysis of a specific user group and then integrated into an LMS, or comparative analyses of existing LMSs are carried out.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture plus workshops</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: Multimedia foundations</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Hausarbeit
incl. documentation</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes:</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr.-Ing. Mengel
Lecturers: Prof. Dr.-Ing. Mengel</td></tr>
</table>

E-Learning (ELEA) E-Learning	
11	**Further information** **Language:** Englisch **Literature:** Lecture notes for the lecture. - A. Schreiber: CBT-Anwendungen professionell entwickeln, Springer Verlag Wien: Studien Verlag. - R. S. Schifman, G. Heinrich: Multimedia Projektmanagement, Springer Verlag - R. Schulmeister: Lernplattformen für das virtuelle Lernen. Evaluation und Didak-tik. ISBN: 3486272500. R. Oldenbourg Verlag: München u.a. P. Baumgartner et. al.: E-Learning Praxishandbuch: Auswahl von Lernplattformen. Marktübersicht - Funktionen - Fachbegriffe. Innsbruck-Wien: Studien Verlag

Game Programming (M-IN-WP07)

<table>
<tr><th colspan="6">Game Programming (GAME)
Game Programming</th></tr>
<tr><td>Identifier
M-IN-WP07</td><td>Workload
180h</td><td>ECTS
6</td><td>Term at study start
ST: 1,2
WT: 1,2</td><td>Frequency
wechselnd</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Praxisprojekt
Übung</td><td>Contact time lecture
60h</td><td>Contact time other
0h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="5">Learning outcomes
The students
- have familiarized themselves independently with a game development framework;
- understand basic concepts of the game engine;
- understand basic concepts of web based game engines;
- understand basics of JavaScript based Frameworks like React, Angular, or Vue;
- understand component based games, especially in educational contexts;
- understand educational game design and general principles of game design;
- are proficient in scripting the relevant engine;
- are able to use the resources of the development platform to create a simple game.</td></tr>
<tr><td>3</td><td colspan="5">Content
Teaching content includes aspects such as
- introduction
- principles of game design and educational game design
- basic game component development for the web
- agile development techniques
- Basics of game engines; scripting
- Basics of animation, animation programming
- Images, sound, modeling, asset management
- Active and agile development of a game in a project work involving all students</td></tr>
<tr><td>4</td><td colspan="5">Course form
2 SWS Lecture and 2 SWS tutorial with discussion and problem discussions / practical project work.</td></tr>
<tr><td>5</td><td colspan="5">Prerequisites for attending
Formal: none
Content: Solid knowledge of HTML, CSS, JavaScript and another programming language, basic understanding of computer graphics, and agile software development. Helpful: Experience with the use of a computer graphics API.</td></tr>
<tr><td>6</td><td colspan="5">Form of examination
Mündliche Prüfung
Hausarbeit
Schriftliche Klausur
Vortrag
Project work; the exact form of examination is determined at the beginning of the semester.</td></tr>
<tr><td>7</td><td colspan="5">Prerequisites for granting ECTS
bestandene Prüfungsleistung
bestandene Studienleistung
Notes:</td></tr>
<tr><td>8</td><td colspan="5">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="5">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="5">Module commissioner and lecturers:
Module commissioner: Prof. Dr. Hallab
Lecturers: N.N.</td></tr>
<tr><td>11</td><td colspan="5">Further information
Language: Deutsch (Englisch)
Literature:
Will be specified at the beginning of the course, depending on the development platform used.</td></tr>
</table>

Simulation (M-IN-WP09)

<table>
<tr><td colspan="6">Simulation (SIMU)
Simulation</td></tr>
<tr><td>Identifier
M-IN-WP09</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1,2
WT: 1,2</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
The students know the methodical basics of modeling and simulation of systems from diverse various application areas. They are familiar with the most important components, the mode of operation and the
handling of a simulation system. The students know the different methods of
time control. They are able to understand and deal with simulation languages and systems. Furthermore, the students are able to independently develop a model for a concrete problem, to implement it and to use it for simulation.
to develop and implement a model for a concrete problem and to carry out simulations professionally. In addition, you will be able to independently develop software components of a simulation system or individually adapt existing.</td></tr>
<tr><td>3</td><td colspan="6">Content
- Problemstellung der Modellierung und Simulation
- Konzepte der Modellbildung
- Kontinuierliche Modelle: Verfahren zur Gewinnung der Systemgleichungen in verschiedenen Anwendungsgebieten
- Methoden der kontinuierlichen Simulation (numerische Verfahren zur Lösung der auftretenden Gleichungen)
- Diskrete Modelle (Entscheidungsmodelle, Reihenfolgeprobleme, Ereignisse)
- Methoden der diskreten Simulation (Petri-Netze, zellulare Automaten, Scheduling)
- Simulationssysteme/Simulatoren (Vorstellung verschiedener Systeme und deren Verwendung)
- Simulationssprachen
- Analyse und Interpretation von Simulationsexperimenten
- Validierung und Verifikation eines Simulationsmodells durch Implementation in einem Simulationssystem.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture plus tutorials</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: High school Mathematics</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur
Mündliche Prüfung</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr.-Ing. Luckas
Lecturers: Prof. Dr.-Ing. Luckas</td></tr>
</table>

Simulation (SIMU) Simulation	
11	**Further information** **Language:** Englisch **Literature:** J. Banks (ed.): Handbook of Simulation: Principles, Methodology, Advances, Applications, and Practice: Modelling, Estimation and Control. John Wiley & Sons, ISBN 978-0-471-13403-9 J. Banks, J. S. II Carson, B. L. Nelson, D. M. Nicol: Discrete-Event System Simulation. Pearson Education, ISBN 978-0-138-15037-2 P. Bratley, B. L. Fox, L. E. Schrage: A Guide to Simulation. Springer, ISBN 978-0-387-96467-6 T. T. Allen: Introduction to Discrete Event Simulation and Agent-based Modeling: Voting Systems, Health Care, Military, and Manufacturing. Springer, ISBN 978-0-857-29138-7 A. M. Law: Simulation Modeling & Analysis. McGraw-Hill Professional, ISBN 978-0-071-25519-6

Maschinelles Sehen (KI) (M-IN-WP31)

<table>
<tr><td colspan="7">Computer Vision (AI) (COVI)
Maschinelles Sehen (KI)</td></tr>
<tr><td>Identifier
M-IN-WP31</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 2
WT: 1</td><td>Frequency
Wintersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung
Praxisprojekt</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25
Präsenzübung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
The students learn the complete process chain of computer vision from image acquisition and data transfer to computational image analysis. They are familiar with the most important machine vision algorithms and are practiced in the application of free open-source software (OpenCV and Keras/TensorFlow with Python-API) and proprietary software (e.g. HALCON or VisionPro).
The different approaches and pros/cons of traditional image processing versus deep learning techniques are understood.
The students are able to familiarize themselves with new topics in the field of computer vision and can present their acquired knowledge in an understandable way.</td></tr>
<tr><td>3</td><td colspan="6">Content
- Introduction and Overview
- Image Acquisition (illumination, lenses, cameras, data interfaces)
- Machine Vision Algorithms (data stuctures, image enhancement, geometric transformations, image segmentation, feature extraction, morphology, edge extraction, camera calibration, 3D-reconstruction, optical character recognition)
- Deep Learning for Machine Vision
- Machine Vision Applications with OpenCV, Keras/TensorFlow and HALCON or VisionPro
Optional (if possible): Excursion to a company in the field of Computer Vision</td></tr>
<tr><td>4</td><td colspan="6">Course form
• Attendance study: Presents lecturers, moderated discussions, group work • Online supervision: (digital) exercises, repetitions (individual or in groups), in-depth studies (quantitative and qualitative methods) • Self-study: learning with study letters, source study, exercises for self- study.Vorlesung und Übung</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Mündliche Prüfung
Vortrag
Hausarbeit</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Presentation of assignment/project work with positive assessment</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Dipl. Phys. Haag-Pichl
Lecturers: Dipl. Phys. Haag-Pichl</td></tr>
</table>

Computer Vision (AI) (COVI) Maschinelles Sehen (KI)	
11	**Further information** **Language:** Englisch (none) **Literature:** A. Nischwitz, M. Fischer, P. Haberäcker, G. Socher: Bildverarbeitung, Springer Vieweg, ISBN 978-3-658-28704-7 C. Steger, M. Ulrich, C. Wiedemann: Machine Vision Algorithms and Applications, Wiley-VCH, ISBN 978-3-527-41365-2 F. Chollet: Deep Learning with Python, Manning Publications, ISBN 978-1617296864 https://docs.opencv.org/4.6.0/index.html https://pyimagesearch.com

Sprachverstehen (KI) (M-IN-WP32)

<table>
<tr><th colspan="6">Natural Language Processing (AI) (NALP)
Sprachverstehen (KI)</th></tr>
<tr><td>Identifier
M-IN-WP32</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
Wintersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung
Praxisprojekt</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25
Präsenzübung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Students learn the fundamentals of automatically processing natural language. They know how to turn sentences into features and how machine learning models can be trained and applied to them. The students know how to solve common applications like sentiment analysis, translation, speech recognition and speech synthesis. They are familiar with common frameworks for implementing natural language processing systems.</td></tr>
<tr><td>3</td><td colspan="6">Content
- Tokenization, stemming, chunking
- Word embeddings
- Recurrent neural networks
- Attention mechanisms and transformers
- Sentiment analysis
- Machine translation
- Speech recognition and synthesis
- Ethical aspects of natural language generation</td></tr>
<tr><td>4</td><td colspan="6">Course form
Attendance study: Presents lecturers, moderated discussions, group work • Online supervision: (digital) exercises, repetitions (individual or in groups), in-depth studies (quantitative and qualitative methods) • Self-study: learning with study letters, source study, exercises for self- study.</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Mündliche Prüfung
Schriftliche Klausur</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. rer. nat. Marx
Lecturers: Prof. Dr. Dahms</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch (none)
Literature:
- Ghallab & Nau & Traverso: Automated Planning. Morgan Kaufmann, 2004.
- Russell & Norvig: Artificial Intelligence – A Modern Approach, 3rd edition. Prentice Hall, 2002.
- Richard Conway, William Maxwell, Louis Miller: Theory of Scheduling, Dover Publications, 1967
- Dana S. Nau. 2007. Current trends in automated planning. AI Magazine, Vol. 28, No. 4.
- Dana S. Nau, Malik Ghallab, and Paolo Traverso. 2015. Blended planning and acting: preliminary approach, research challenges. In Proceedings of the Twenty-Ninth AAAI Conference on Artificial Intelligence (AAAI'15). AAAI Press 4047-4051</td></tr>
</table>

Fortgeschrittenes Data Mining mit R und JavaScript auf GNU/Linux (KI) (M-IN-WP34)

<table>
<tr><th colspan="6">Advanced Data Mining with R and JavaScript on GNU/Linux (AI) (ADAM)
Fortgeschrittenes Data Mining mit R und JavaScript auf GNU/Linux (KI)</th></tr>
<tr><td>Identifier
M-IN-WP34</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 2
WT: 1</td><td>Frequency
Wintersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
After completing the module, students will be able to:
- apply basic empiric methods to evaluate characteristics of experimental data
- classify and apply basic methods and algorithms of data mining for the analysis of scientific data
- to write small programs independently in the statistical programming language R and JavaScript
- generate reusable data analysis and visualization web components using HTML, CSS, and Javascript
- use such web components to analyze and visualize data
- create interactive scientific plots that enable the user to better explore scientific data and thus aid the scientist in hypothesis formation and validation</td></tr>
<tr><td>3</td><td colspan="6">Content
NOTE that the WHOLE COURSE will be held on a GNU/Linux operating system. Students are highly recommended to prepare their hardware either with a (dual boot) GNU/Linux operating system or use a virtual machine GNU/Linux installation, or (least recommended) use the Windows 10 or 11 subsystem.

The course covers the following topics
- Introduction to or repetition of basic statistics, respectively
- standard algorithms and methods in applied data science, and implementation in R and/or JavaScript; these comprise:
- statistical distribution function estimation methods
- normalization and data transformation
- Distances and correlation coefficients
- Clustering and classification, basics of data mining
- Regression and basic statistical learning methods
- principal component analysis
- basics in text mining and text corpus analysis
- Visualization of results (boxplot, heat map, dendrogram, etc.)
Additional topics are:
- Basics of the statistical programming language R
- Basics of ECMAScript and its usage in statistics and web component development
- programming of reusable web components: covering specifics like the shadow DOM and asynchronous functions</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture and Tutorial</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: In order to be able to pass the course successfully, students must have basic experience in programming of JavaScript and some other programming language. Student must be able to use the GNU/Linux operating system, particularly the terminal and command-line-interface. Students must have experience in using code versioning tools like git.</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur
Hausarbeit
Mündliche Prüfung
Vortrag</td></tr>
</table>

	Advanced Data Mining with R and JavaScript on GNU/Linux (AI) (ADAM) **Fortgeschrittenes Data Mining mit R und JavaScript auf GNU/Linux (KI)**
7	**Prerequisites for granting ECTS** bestandene Prüfungsleistung bestandene Studienleistung Notes: passed examination
8	**Utilization of the module (in other study courses)** This module is not used in other courses.
9	**Weight for the final score** Weighting according to the ECTS points
10	**Module commissioner and lecturers:** **Module commissioner:** Prof. Dr. rer. nat. Hallab **Lecturers:** Prof. Dr. rer. nat. Hallab
11	**Further information** **Language:** Englisch **Literature:** - https://www.w3schools.com/r/default.asp - https://www.w3schools.com/js/default.asp - James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning (Vol. 112, p. 18). New York: springer. - https://en.wikibooks.org/wiki/Statistics - Heumann, C., & Shalabh, M. S. (2016). Introduction to statistics and data analysis. Springer International Publishing Switzerland.

Planen und Terminisierung (KI) (M-IN-WP35)

<table>
<tr><td colspan="7">Planning and Scheduling (AI) (PLANS)
Planen und Terminisierung (KI)</td></tr>
<tr><td>Identifier
M-IN-WP35</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
wechselnd</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
The students know concepts, methods, and tools for task-level planning and scheduling.
Methodological competency: The students know the state-of-the-art in task planning and are able to select and apply adequate methods for use in robotics applications.
Individual competency: Improved ability to perform abstract thinking and logical reasoning. Ability to formalize domain concepts in appropriate logics.</td></tr>
<tr><td>3</td><td colspan="6">Content
• Knowledge representation
• Formalizing action and action theories
• State space planning: STRIPS and friends
• Plan space planning: POP and friends
• Graph-based planning
• SAT-based planning
• HTN planning
• Scheduling and resource constraints</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture and Tutorials</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Mündliche Prüfung
Hausarbeit</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Bestandene Modulprüfung</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. rer. nat. Marx
Lecturers: Awaad</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
- Ghallab & Nau & Traverso: Automated Planning. Morgan Kaufmann, 2004.
- Russell & Norvig: Artificial Intelligence – A Modern Approach, 3rd edition. Prentice Hall, 2002.
- Richard Conway, William Maxwell, Louis Miller: Theory of Scheduling, Dover Publications, 1967
- Dana S. Nau. 2007. Current trends in automated planning. AI Magazine, Vol. 28, No. 4.
- Dana S. Nau, Malik Ghallab, and Paolo Traverso. 2015. Blended planning and acting: preliminary approach, research challenges. In Proceedings of the Twenty-Ninth AAAI Conference on Artificial Intelligence (AAAI'15). AAAI Press 4047-4051
- Malik Ghallab, Dana Nau, Paolo Traverso: Automated Planning and Acting. Cambridge University Press. 2016.</td></tr>
</table>

Netzwerksicherheit (M-IN-WP36)

<table>
<tr><th colspan="7">Network Security (NETS)
Netzwerksicherheit</th></tr>
<tr><td>Identifier
M-IN-WP36</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Network security is a critical component of modern information technology systems.
After attending this course, the students will be able to:
- describe different network architectures and concepts and be able to evaluate them with regards to their security properties,
- reproduce which different typical threats exist in the network and which challenges exist,
- analyze and evaluate a given network architecture with modern tools, such as nmap and wireshark,
- know and apply different strategies and tools for detection and response and evaluate them in terms of advantages and disadvantages,
- know and be able to apply security measures and protocols on the different network layers,
- use classic network security tools such as firewalls and intrusion detection systems, including their placement in the network topology,
- develop suitable response strategies and to solve security problems of other exemplary topics such as in the wireless networking or distributed systems domain.</td></tr>
<tr><td>3</td><td colspan="6">Content
Attacks and defenses in the context of network and operating system security, including:
- Principles of networking fundamentals and IT security concepts
- Vulnerability and risk assessment using scanning tools like Nmap and monitoring tools such as Wireshark
- Attacks and security measures for different network layers, including application layer (PGP, S/Mime, Web security, DNSSEC), Transport layer (TLS), network layer (IPSEC), data link (PPPoE) and medium access layer (WPA*).
- Secure networking architecture elements such as firewalls, intrusion detection systems, monitoring systems, virtual private networks
- Security measures for authentication, anonymity, and trust, especially in distributed systems
- Network steganography
- Decentralized systems: Blockchain, peer-to-peer networks, opportunistic networks.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture and Tutorials</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: IT Security, Communication Networks</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur
Mündliche Prüfung</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr.-Ing. Graffi
Lecturers: Prof. Dr.-Ing. Graffi</td></tr>
</table>

Network Security (NETS) Netzwerksicherheit	
11	**Further information** **Language:** Englisch **Literature:** - James F. Kurose and Keith W. Ross: "Computer Networking: A Top-Down Approach" - Charlie Kaufman, Radia Perlman, and Mike Speciner: "Network Security: Private Communication in a Public World" - Ross Anderson: "Security Engineering: A Guide to Building Dependable Distributed Systems" Steffen Wendzel:” IT-Sicherheit für TCP/IP- und IoT-Netzwerke: Grundlagen, Konzepte, Protokolle, Härtung (German Edition)

autonome und mobile Roboter (KI) (M-IN-WP38)

<table>
<tr><th colspan="6">Autonomous and Mobile Robots (AI) (AROB)
autonome und mobile Roboter (KI)</th></tr>
<tr><td>Identifier
M-IN-WP38</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
Wintersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
- Students will be able to describe and classify the different AI paradigms for mobile robots (reactive, deliberative, hybrid).
- Students can explain and evaluate the most important sensors and actuators for mobile robots.
Students can describe compare and use the basic planning and navigation methods in mobile robotics.
- Students can discuss basic approaches to robot learning and multi-robot and human-robot interaction.
- Students can present the state of knowledge and current trends in mobile robotics and explain them using example robots.
- Students will be able to design and program mobile robots yourself.</td></tr>
<tr><td>3</td><td colspan="6">Content
- Reactive behavior
- Sensors
- Actuators, kinematics of drives
- Hybrid deliberative/reactive behavior
- Action planning
- maps, self-localization
- path planning, navigation
- Robot learning
- Error detection and healing
- Multi-robot
- Human-robot interaction
- Current trends
- example platforms</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture plus workshops</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Mündliche Prüfung
Vortrag
Hausarbeit</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. rer. nat. Marx
Lecturers: Prof. Dr. rer. nat. Marx</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
- Siciliano, Bruno; Khatib, Oussama: Handbook of Robotics. Springer. Berlin-Heidelberg. 2016.
- J. Hertzberg, K. Lingemann, A. Nüchter: Mobile Roboter - Springer Vieweg 2012</td></tr>
</table>

Fortgeschrittenes Software-Engineering: Prinzipien und Strukturen (üb) (M-IN-WP40)

<table>
<tr><th colspan="6">Advanced Software Engineering: Principles & Structures (comprehensive) (ADSE)
Fortgeschrittenes Software-Engineering: Prinzipien und Strukturen (üb)</th></tr>
<tr><td>Identifier
M-IN-WP40</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 2
WT: 1</td><td>Frequency
Wintersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Seminar</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
The students know advanced topics and interrelationships in the subject areas of software engineering: Requirements engineering, specification as well as system architecture, development processes and related aspects of quality and security. The students therefore are familiar with modern principles and paradigms in the field of software design, development, deployment and operation. They can apply this knowledge to practical problems. The analysis, design and development of software systems can be actively accompanied by the students as part of a leading team. They also know how to coordinate the activities in the development and deployment chain of large software systems and are able to assess technical and economic risks as well as software quality.

Competencies
The course covers aspects of the development process from the determination of requirements to quality assurance. Students use common platforms, frameworks and tools to train their ability to plan, monitor and control large complex projects.
Working on questions in small groups trains in dealing with conflicting goals, promotes discussion, critical faculties and presentation.
The module contributes in particular to the development of leadership competences. The handling of case studies and case studies promotes the necessary decision-making competence. In addition, rhetorical skills and the ability to convince and motivate employees are of great importance.

Self-motivation/self-study
- Homework / Exercise (Width)
After an introductory presentation, the students work independently into concrete projects and gain in particular an impression of the complexity.
- Homework / Exercise (Design)
The students develop specific, corresponding solutions for selected questions in software engineering and develop concrete implementation approaches.
All previously during the study program acquired knowledge is brought together here</td></tr>
<tr><td>3</td><td colspan="6">Content
Requirements engineering: methods and processes for the definition, documentation and management of functional and non-functional requirements.
- Software architecture: design and construction principles, paradigms and structural styles (like microservices), reference architectures, frameworks and libraries.
- Software development process: management of complex software development projects, management of soft- ware product lines, versioning, prototyping, agile methods
- Software deployment, delivery and operating: Common and crucial aspects of the deployment, delivery and operating chain of software systems as far as these are associated to software engineering: e.g. container, distributed systems, cloud computing, software as a service (SaaS), edge and fog computing</td></tr>
<tr><td>4</td><td colspan="6">Course form
Seminar</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur
Vortrag
Written examination in the form of a self-directed project including presentation (presentation 40% /documentation 60%)</td></tr>
</table>

Advanced Software Engineering: Principles & Structures (comprehensive) (ADSE) Fortgeschrittenes Software-Engineering: Prinzipien und Strukturen (üb)	
7	**Prerequisites for granting ECTS** bestandene Prüfungsleistung Notes: Passed exam
8	**Utilization of the module (in other study courses)** This module is not used in other courses.
9	**Weight for the final score** Weighting according to the ECTS points
10	**Module commissioner and lecturers:** **Module commissioner:** Prof. Dr. Kulesz **Lecturers:** Prof. Dr. Kulesz
11	**Further information** **Language:** Englisch **Literature:** Sommerville, I. Software Engineering, Pearson. Most recent edition.

Modell basiertes Software Engineering (M-IN-WP43)

<table>
<tr><td colspan="7">Model-Based Software Engineering (MBSE)
Modell basiertes Software Engineering</td></tr>
<tr><td>Identifier
M-IN-WP43</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 2
WT: 1</td><td>Frequency
Wintersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
By the end of this module, students will be able to:
- Identify and describe the fundamental concepts and terminology of model-based software engineering.
- Explain the significance of modeling in software engineering.
- Create requirements models (context models, goal models, scenarios)
- Create static and dynamic architecture models
- Evaluate different modeling approaches and tools and choose the appropriate one for a given software project.
- Critically assess the quality of software models
- Develop comprehensive models for complex software systems</td></tr>
<tr><td>3</td><td colspan="6">Content
• Introduction to Model-Based Software Engineering
o Overview of model-based software engineering
o Benefits and challenges of model-based software engineering
o Key concepts and terminology
• Modeling Requirements
o Context modeling
o Goal modeling
o Scenario modeling
• Modeling Software Architecture
o Static architecture models
o Dynamic architecture models
• Analyzing and Modeling Variant-Intensive Systems
o Identifying variability in software system
o Approaches to modeling variant-intensive systems
• Model-Based Quality Assurance
o Validation and verification approaches for model-based artifacts
o Model-based testing</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture and Tutorials, practical project</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur
Mündliche Prüfung
Hausarbeit</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. Brings
Lecturers: Prof. Dr. Brings</td></tr>
</table>

Model-Based Software Engineering (MBSE) Modell basiertes Software Engineering	
11	**Further information** **Language:** Englisch **Literature:** - Brambilla, M., Cabot, J., Wimmer, M. (2022). Model-Driven Software Engineering in Practice. Germany: Springer International Publishing. - Rumpe, B. (2017). Agile Modeling with UML: Code Generation, Testing, Refactoring. Germany: Springer International Publishing. - Burgueño, L., Ciccozzi, F., Famelis, M. et al. Contents for a Model-Based Software Engineering Body of Knowledge. Softw Syst Model 18, 3193–3205 (2019). https://doi.org/10.1007/s10270-019-00746-9 - Kautz, O., Roth, A., Rumpe, B. (2018). Achievements, Failures, and the Future of Model-Based Software Engineering. In: Gruhn, V., Striemer, R. (eds) The Essence of Software Engineering. Springer, Cham. https://doi.org/10.1007/978-3-319-73897-0_13 - Selic, B. (2008) Personal reflections on automation, programming culture, and model-based software engineering. Autom Softw Eng 15, 379–391. https://doi.org/10.1007/s10515-008-0035-7 - Ciccozzi, F., et al. (2018). Towards a body of knowledge for model-based software engineering. In Proceedings of the 21st ACM/IEEE International Conference on Model Driven Engineering Languages and Systems: Companion Proceedings (MODELS '18). Association for Computing Machinery, New York, NY, USA, 82–89. https://doi.org/10.1145/3270112.3270121 - Broy, M. (2011). Seamless Method- and Model-based Software and Systems Engineering. In: Nanz, S. (eds) The Future of Software Engineering. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-15187-3_2 - Pohl, K., Böckle, G. and Linden, F. v. d. (2005) Software Product Line Engineering - Foundations, Principles, and Techniques, Springer. - ITU (2018). Recommendation Z.151: User Requirements Notation (URN) - Language Definition, Technical report, International Telecommunication Union. - ITU (2011) Recommendation Z.120: Message Sequence Chart (MSC), Technical report, International Telecommunication Union. - OMG (2017) Unified Modeling Language. Technical report, Object Management Group.

Sicheres und geschütztes Programmieren in Rust (M-IN-WP44)

<table>
<tr><td colspan="6">Safe and Secure Programming in Rust (RUST)
Sicheres und geschütztes Programmieren in Rust</td></tr>
<tr><td>Identifier
M-IN-WP44</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 2
WT: 1</td><td>Frequency
wechselnd</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Vorlesung
Übung</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
By successful completion of this course, students obtain the following skills:
- They internalized that programming in safety-critical domains is fundamentally different from programming in 'regular' domains.
- They understand how strict programming languages can contribute to safe and secure programming.
- They can apply basic and advanced concepts of the Rust programming language in practical projects.
- They can build robust Rust applications for use in safety-critical domains.</td></tr>
<tr><td>3</td><td colspan="6">Content
Malfunctions of software in safety-critical systems as well as cyberstrikes can lead to severe losses including death and environmental harm. Hence, when building software for such environments the use of safe and secure programming languages is essential. One suitable programming language for this use case is Rust. Moreover, Rust is also continuously gaining popularity and is used in leading open source projects such as the Linux kernel or the Firefox browser. Rust is particularly attractive because it enables both system-level and application-oriented programming while pursuing the goal of making programs safe and secure.
The first part of this course will start with an introduction to safety-critical systems. Afterwards, the basics of Rust (syntax, concepts) will be explained and comparisons to other programming languages (e.g. Java or C/C++) will be drawn. Here, the focus will be on memory management without a garbage collector and its implications on safety and security.
In the second part of this course, the participants will deepen the theory through practical work on real
development projects. The course follows the concept of 'research-based learning' and therefore requires an adequate degree of initiative and willingness to learn. In particular, we expect that students learn independently by means of designated tutorials.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Lecture and Tutorials, practical project</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur
Mündliche Prüfung
Hausarbeit</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: SGL-M-IN Kulesz
Lecturers: SGL-M-IN Kulesz</td></tr>
</table>

Safe and Secure Programming in Rust (RUST) Sicheres und geschütztes Programmieren in Rust	
11	**Further information** **Language:** Englisch **Literature:** - “Programming Rust: Fast, Safe Systems Development”, Jim Blandy, Jason Orendorff, Leonora Tindall, 2nd. ed, 2021, O'Reily - “Embedded software development for safety-critical systems”, Chris Hobbs, 2nd ed., 2020, CRC Press

Individuelle Profilbildung Kerndisziplinen (M-IN-WP48)

<table>
<tr><th colspan="6">Individual Specialization Core Disciplines (ISCD)
Individuelle Profilbildung Kerndisziplinen</th></tr>
<tr><td>Identifier
M-IN-WP48</td><td>Workload
180h</td><td>ECTS
6</td><td>Term at study start
ST: 1,2
WT: 1,2</td><td>Frequency
jedes Semester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Selbststudium und Konsultationen</td><td>Contact time lecture
0h</td><td>Contact time other
30h</td><td>Self-studies
150h</td><td>Planned group size
Veranstaltung: 1</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
The elective module targets the specialization of students in the core disciplines of computer science. In the frame of an individual task, students are supposed to show that they are able to solve complex problems from computer science mostly on their own with only limited supervisor support. Students are supposed to become acquainted with methods, technologies and concepts for solving the given problems on their own.</td></tr>
<tr><td>3</td><td colspan="6">Content
The topics shall be selected from current topics in computer science. The definition of the topic is worked out in a bilateral dialog between the student and the supervisor. The given task must be formulated in a way such that it cannot be solved only with competencies taught in compulsory courses. In addition, overlap with content from other course modules attended by the student must not exceed 30%.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Self-studies and consultations</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: None</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Vortrag
Hausarbeit</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Bestandene Modulprüfung</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: SGL-M-IN Kulesz
Lecturers: Alle Dozenten des Studiengangs Master Informatik / Computer Science (international)</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch (-)
Literature:
Individually selected based on the subject</td></tr>
</table>

Wahlpflichtfächer Interdisciplinary

ERP in der Cloud (M-IN-WP37)

ERP in the Cloud (ERPC) ERP in der Cloud						
Identifier M-IN-WP37	**Workload** 180h	**ECTS** 6	**Term at study start** ST: 1 WT: 2		**Frequency** Wintersemester	**Duration** 1 Semester
1	**Course** Vorlesung Übung		**Contact time lecture** 30h	**Contact time other** 30h	**Self-studies** 120h	**Planned group size** Veranstaltung: 25
2	**Learning outcomes** The students know basic principles about Cloud Computing, Cloud Development, SAP Business Technology Platform and how international companies make use of SAP Business Technology Platform and other Cloud Products. Especially the required techniques and programming languages for Cloud Development are understood by the students. The students know how to develop, deploy, test and run Cloud Application on SAP BTP.					
3	**Content** - GxP requirements, Documentation Practices (optional) - Cloud Computing, IaaS, PaaS, SaaS - Business Technology Platform (BTP) Account Structure, Services, Integration in existing landscape - BTP BAS (Business Aplication Studio), Good coding principles - Security/Authentication/Authorization in the cloud - UI5 Workframe, CAP Modell, ODATA Protocol, CDS (HDI Container) - LC/NC (low code/no code) Development (controls/navigation)					
4	**Course form** Lecture plus workshops					
5	**Prerequisites for attending** Formal: none Content: JavaScript, Web technologies (e.g HTML, CSS, etc), APIs, CRUD Operations					
6	**Form of examination** Mündliche Prüfung Vortrag Hausarbeit					
7	**Prerequisites for granting ECTS** bestandene Prüfungsleistung Notes: Passed exam					
8	**Utilization of the module (in other study courses)** This module is not used in other courses.					
9	**Weight for the final score** Weighting according to the ECTS points					
10	**Module commissioner and lecturers:** **Module commissioner:** Prof. Dr. rer. nat. Marx **Lecturers:** Prof. Dr. rer. nat. Marx					
11	**Further information** **Language:** Deutsch (einzelne Abschnitte in Englisch) **Literature:** SAP Academy https://open.sap.com/ UI5 Documentation https://ui5.sap.com CAP Dokumentation https://cap.cloud.sap/docs/about/ UI5 Walkthrough https://ui5.sap.com/#/topic/3da5f4be63264db99f2e5b04c5e853db OData Documentation https://www.odata.org/documentation/					

Innovation und IT (übergreifend) (M-IN-WP39)

<table>
<tr><th colspan="6">Innovation & IT (comprehensive) (INOV)
Innovation und IT (übergreifend)</th></tr>
<tr><td>Identifier
M-IN-WP39</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1
WT: 2</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Seminar</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Students know and recognize basic digital economy concepts and IS-based business models. They are familiar with ideas concerning the application of IS-based innovations, networks and platforms for communication, inter- action and transaction in a globalized world and can analyze and apply them.
Students are aware of the digital economy’s main innovative concepts, methods, and instruments. Students are able to distinguish IS-based business model applications, implementations, and innovations. They are able to reflect, analyze, discuss and apply those concepts. Students are able to assess the value of digital business, trans- formation, and the economics of digitization. They are capable of assessing applied practical implementations in a competent way. Students recognize business transformations induced by IS innovations, and are able to reflect and apply concepts and models to actual cases by design. They are capable of reflecting potential social and cultural impacts and gain knowledge in a self-directed manner.

Due to a comprehensive statement of current topics students gain broad knowledge. In-depth insights into innovative best demonstrated available technology (such as big data and business analysis) and its business application deepen their knowledge. Decision-making under uncertain conditions is required.
Students team up in small groups and are able to lead small teams in a responsible way, research and apply knowledge in a self-directed manner, and discuss their results. They are able to promote professional development of their fellow students’ appropriate knowledge and discuss their results with peers and with experts.
Self-motivation/self-study
• Homework/Exercise (Breadth)
Fundamental concepts of economic decisions (eg value chains and business systems) are repeated. Concepts of innovation management have to be read, analyzed and discussed.
• Homework / Exercise (Depth)
Important topics such as neo-mediation or disintermediation are prepared in self-study and subsequently dis- cussed in detail.</td></tr>
<tr><td>3</td><td colspan="6">Content
Innovation, digital economy, transformation classification in a scientific context
Current topics and best demonstrated available IS-technology
Terminology, concepts and models: innovation, digital economy, transformation, and IS-based business models Selected case studies
Applied digital economy, transformation applications
Trends (e. g. mobile business)
Social and cultural context and impact</td></tr>
<tr><td>4</td><td colspan="6">Course form
Seminar</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: none</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Schriftliche Klausur
Written examination in the form of a self-directed project including presentation (100 %)</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
</table>

Innovation & IT (comprehensive) (INOV) Innovation und IT (übergreifend)	
9	**Weight for the final score** Weighting according to the ECTS points
10	**Module commissioner and lecturers:** **Module commissioner:** Prof. Dr. rer. nat. Marx **Lecturers:** Prof. Dr. rer. nat. Marx
11	**Further information** **Language:** Englisch **Literature:** Christensen, C. M.: The Innovator’s Dilemma. Boston, MA, USA, Harvard Business Review Press Clement, R., Schreiber, D.: Internet-Ökonomie – Grundlagen und Fallbeispiel der vernetzten Wirtschaft. Berlin, Springer Gabler Day, G. S.; Moorman, C.: Strategy from the Outside in. London, McGraw-Hill Kaufmann, T.: Geschäftsmodelle in Industrie 4.0 und dem Internet der Dinge. Berlin, Springer Vieweg Kollmann, T.: E-Business. Berlin, Springer Gabler Laudon, K. C.; Traver, C. G.: E-Commerce 2016: Business, Technology, Society. Upper Saddle River, NJ, USA, Pearson Osterwalder, A.; Pigneur, Y.: Business Model Generation. Hoboken, NJ, USA, John Wiley & Sons Rogers, D. L.: Digital Transformation Playbook: Rethink Your Business for the Digital Age. New York, Columbia University Press Westerman, G.; Bonnet, D.; McAfee, A.: Leading Digital: Turning Technology into Business Transformation. Boston, MA, USA, Harvard Business Review Press Wirtz, B. W.: Electronic Business. Berlin, Springer Gabler Most recent edition. Relevant journal articles, e.g.: Gimpel, H.; Röglinger, M. (2015): Digital Transformation: Changes and Chances – Insights based on an Empiri- cal Study. Fraunhofer Institute for Applied Information Technology Hansen, R.; Sia, S. K. (2015): Hummel's Digital Transformation Toward Omnichannel Retailing: Key Lessons Learned. MIS Quarterly Executive, Vol. 14, Issue 2 Kane, G. C.; Plamer, D.; Phillips, A. N.; Kiron, D.; Buckley, N. (2015): Strategy, not Technology, Drives Digital Transformation. MIT Sloan Management Review and Deloitte University Press Matt, C.; Hess, T.; Benlian, A. (2015): Digital Transformation Strategies; Business & Information Systems En- gineering, Vol. 57, Issue 5

Geschäftsmodelle und IT-Strategie (übergreifend) (M-IN-WP41)

Business Models and IT-Strategy (comprehensive) (BMST) Geschäftsmodelle und IT-Strategie (übergreifend)						
Identifier M-IN-WP41	**Workload** 180h	**ECTS** 6	**Term at study start** ST: 2 WT: 1		**Frequency** Wintersemester	**Duration** 1 Semester
1	**Course** Vorlesung Übung		**Contact time lecture** 30h	**Contact time other** 30h	**Self-studies** 120h	**Planned group size** Veranstaltung: 25
2	**Learning outcomes** After successfully completing the module, students will be able to: • to develop different business models, to identify appropriate corresponding IT strategies and to assess possible scenarios by means of discussions, current case studies and research approaches critically • to apply methods so that companies can take advantage of changes in the market through appropriate transformations of value chains and business systems to their advantage • to develop IT strategies that support the company's objectives or enable specific business models • to explain and to analyze objectives and architectures of inter-company networking using current exam- ples from various sectors • to describe the role that IT can play as a differentiating factor in the implementation of innovative busi- ness models, and the impact of IT innovations on the business and IT strategy					
3	**Content** Development of an IT strategy and alignment with the business strategy Business models and development strategies Relationship between business model and IT strategy IT as an enabler of innovative business models IT Governance: Targeting the IT strategy according to the business strategy, e.g. by means of COBIT					
4	**Course form** Lecture					
5	**Prerequisites for attending** Formal: none Content: none					
6	**Form of examination** Schriftliche Klausur Vortrag Hausarbeit Written examination in the form of a self-directed project (business model and corresponding IT strategy) including presentation (Presentation 40% /documentation 60%)					
7	**Prerequisites for granting ECTS** bestandene Prüfungsleistung Notes: Passed exam					
8	**Utilization of the module (in other study courses)** This module is not used in other courses.					
9	**Weight for the final score** Weighting according to the ECTS points					
10	**Module commissioner and lecturers:** **Module commissioner:** Prof. Dr. Mehler-Bicher **Lecturers:** Prof. Dr. Mehler-Bicher					

Business Models and IT-Strategy (comprehensive) (BMST) Geschäftsmodelle und IT-Strategie (übergreifend)	
11	**Further information** **Language:** Englisch **Literature:** Becker, J.; Knackstedt, R.; Pfeiffer, D.: Wertschöpfungsnetzwerke, Physica. Buchta, D.; Eul, M.; Schulte-Croonenberg, H.: Strategisches IT Management, Gabler. Gassmann, O.; Frankenberger, K; Csik, M.: Geschäftsmodelle entwickeln, Hanser Osterwalder, A.; Pigneur, Y. Business Model Generation Keuper, F.; Schomann, M.; Grimm, R.: Strategisches IT Management. Management von IT und IT gestütztes Management, Gabler. McKeen, J.D.; Smith, H.: IT Strategy. Prentice Hall. Most recent edition.

Aktuelle Themen im Software Engineering (übergreifend) (M-IN-WP45)

<table>
<tr><th colspan="6">Current Topics in Software Engineering (comprehensive) (CTSE)
Aktuelle Themen im Software Engineering (übergreifend)</th></tr>
<tr><td>Identifier
M-IN-WP45</td><td>Workload
180h</td><td>ECTS
6</td><td>Term at study start
ST: 1
WT: 2</td><td>Frequency
Sommersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Seminar</td><td>Contact time lecture
15h</td><td>Contact time other
45h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25</td></tr>
<tr><td>2</td><td colspan="5">Learning outcomes
The students
- master and apply fundamental and advanced methods for solving complex problems using software engineering methods.
- select suitable conceptual or theoretical approaches and use appropriate techniques to solve a selected and relevant research- or practice-oriented problem.
- expand and deepen their knowledge in project management.
- communicate findings clearly and effectively in both written and spoken formats.</td></tr>
<tr><td>3</td><td colspan="5">Content
This course offers an in-depth exploration of current topics in software engineering, selected by the instructor to reflect emerging trends or challenges in software engineering. Students will explore the topic through a mix of introductory lectures, reading assignments, presentations, discussion, and project work. The course emphasizes skills like analyzing current practices, designing solutions, and presenting findings.</td></tr>
<tr><td>4</td><td colspan="5">Course form
Seminar</td></tr>
<tr><td>5</td><td colspan="5">Prerequisites for attending
Formal: none
Content: Basic software engineering knowledge</td></tr>
<tr><td>6</td><td colspan="5">Form of examination
Vortrag
Hausarbeit
Project work, term paper, presentations, the exam format is determined and announced at the beginning of the semester</td></tr>
<tr><td>7</td><td colspan="5">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Bestandene Modulprüfung</td></tr>
<tr><td>8</td><td colspan="5">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="5">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="5">Module commissioner and lecturers:
Module commissioner: Prof. Dr. Brings
Lecturers: Prof. Dr. Brings</td></tr>
<tr><td>11</td><td colspan="5">Further information
Language: Englisch
Literature:
- B. Boehm, „A view of 20th and 21st century software engineering“, in Proceedings of the 28th International Conference on Software Engineering, in ICSE ’06. New York, NY, USA: ACM, 2006, S. 12–29. doi: 10.1145/1134285.1134288.
- R. L. Glass, I. Vessey, und V. Ramesh, „Research in software engineering: an analysis of the literature“, Information and Software technology, Bd. 44, Nr. 8, S. 491–506, 2002.
- B. A. Kitchenham und S. Charters, „Guidelines for performing systematic literature reviews in software engineering“, School of Computer Science and Mathematics, Keele University, 2007.
- Additional literature will be announced in the first session according to selected topic</td></tr>
</table>

Individuelle Profilbildung (Master, übergreifend) (M-IN-WP46)

<table>
<tr><th colspan="6">Individual Profiling (Master) (IPROF)
Individuelle Profilbildung (Master, übergreifend)</th></tr>
<tr><td>Identifier
M-IN-WP46</td><td>Workload
180h</td><td>ECTS
6</td><td colspan="2">Term at study start
ST: 1,2
WT: 1,2</td><td>Frequency
jedes Semester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Selbststudium und Konsultationen</td><td>Contact time lecture
0h</td><td>Contact time other
30h</td><td>Self-studies
150h</td><td>Planned group size
Veranstaltung: 1</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
The elective module fosters students to address broader, interdisciplinary topics outside of the computer science core disciplines. In the frame of an individual task, students are supposed to show that they are able to tackle problems in other disciplines (e.g. economics, social sciences, arts, history, education) that are influenced by computer science. Students are supposed to become acquainted with challenges in other disciplines and to provide a contribution towards their solution. The core of the contribution must not have a technical nature.</td></tr>
<tr><td>3</td><td colspan="6">Content
The topics shall be selected from current topics in disciplines outside of computer science. The definition of the topic is worked out in a bilateral dialog between the student and the supervisor. The given task must be formulated in a way such that it cannot be solved only with competencies taught in compulsory courses. In addition, overlap with content from other course modules attended by the student must not exceed 15%.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Self-studies and consultations</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: keine</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Vortrag
Hausarbeit</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Passed exam</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Admin
Lecturers: Alle Dozenten des Studiengangs Master Informatik / Computer Science (international)</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
Current literature depending on the chosen topic.</td></tr>
</table>

Wahlpflichtfächer Mathematics

Fortgeschrittene Themen in Diskreter Optimierung (M-IN-WP47)

<table>
<tr><td colspan="6">Advanced Topics in Discrete Optimization (ATDO)
Fortgeschrittene Themen in Diskreter Optimierung</td></tr>
<tr><td>Identifier
M-IN-WP47</td><td>Workload
180h</td><td>ECTS
6</td><td>Term at study start
ST: 2
WT: 1,3</td><td>Frequency
Wintersemester</td><td>Duration
1 Semester</td></tr>
<tr><td>1</td><td colspan="2">Course
Seminar</td><td>Contact time lecture
30h</td><td>Contact time other
30h</td><td>Self-studies
120h</td><td>Planned group size
Veranstaltung: 25
Präsenzübung: 25</td></tr>
<tr><td>2</td><td colspan="6">Learning outcomes
Students are able to work out the current state of the art on a specific research topic in the field of discrete optimization and understand the content of scientific articles in international peer-reviewed journals. They are able to present the core statements of an article in a scientific presentation in a way that is understandable and appealing to the relevant target group. Students are able to critically scrutinize scientific findings and evaluate their significance for theory and practice. Finally, students acquire in-depth knowledge and skills for scientific work.</td></tr>
<tr><td>3</td><td colspan="6">Content
Current and relevant publications in established international peer-reviewed journals on the following topics and their applications in practice will be covered:
- Combinatorial Optimization
- Network Optimization
- Multiobjective Optimization
- Integer Optimization
- etc.</td></tr>
<tr><td>4</td><td colspan="6">Course form
Seminaristic</td></tr>
<tr><td>5</td><td colspan="6">Prerequisites for attending
Formal: none
Content: keine</td></tr>
<tr><td>6</td><td colspan="6">Form of examination
Mündliche Prüfung
Vortrag</td></tr>
<tr><td>7</td><td colspan="6">Prerequisites for granting ECTS
bestandene Prüfungsleistung
Notes: Bestandene Modulprüfung</td></tr>
<tr><td>8</td><td colspan="6">Utilization of the module (in other study courses)
This module is not used in other courses.</td></tr>
<tr><td>9</td><td colspan="6">Weight for the final score
Weighting according to the ECTS points</td></tr>
<tr><td>10</td><td colspan="6">Module commissioner and lecturers:
Module commissioner: Prof. Dr. Schäfer
Lecturers: Prof. Dr. Schäfer</td></tr>
<tr><td>11</td><td colspan="6">Further information
Language: Englisch
Literature:
- Recent scientific papers in the field of discrete optimization
- Hamacher, H. W., & Klamroth, K. (2000).Lineare und Netzwerk-Optimierung / Linear and Network-Optimization. Vieweg+Teubner Verlag.</td></tr>
</table>