Universität Bremen

Faculty 03: Mathematics/Computer Sciences

Wintersemester 23/24

Module Guide

for the study of

Artificial Intelligence and Intelligent Systems

valid in connection with the examination regulations MPO 2024

Generated: October 30, 2023

Sem	Foundations				Major/ Minor		Research		Gen. Stud.	Master Thesis	Summe
1	F-AMAI Advanced Methods of AI P 6	F-AML Advanced Machine Learning P 6	F-IIS Integrated Intelligent Systems P 6	F-ATE AI Algorithms: Theory and Engineering P 6					S-CDF Cross-Disciplinary Foundations P 6		30
2					M-CER1 Cognition-Enabled Robotics P 6	M-MLCS1 Machine Learning and Cognitive Syst. P 6	12 R-PJ Master Project P 12	R-MS Master Seminar P 3	Free Choice 3		30
3					M-CER2 vs. M-MLCS2 WP 6			R-R Guided Research P 6	Free Choice 6		30
4										T-MT Master Thesis P 30	30

Remarks:

- For the individual modules is indicated:
  - Module identifier
  - Module title
  - Compulsory module vs. compulsory elective module (P vs. WP)
  - Number of credit points
- *Free Choice* is not modularised.

Index by areas of study

Module 03-INF-MA-AI-F-AMAI: Advanced Methods of AI
Advanced Methods of AI

Assignment to areas of study:	Content-related prior knowledge or skills:
• Foundations	none

Learning content:

1 Modeling intelligent systems as “rational agents”
2 Problem-solving using searching methods
- heuristic search, constraint-based search, optimizing search
3 Problem-solving using logic-based representation and reasoning systems (symbolic knowledge representation)
- propositional and predicate logic based knowledge representations + ontologies (description logic)
- short discussion of common-sense reasoning (frame, qualification & ramification problem)
- action planning
4 Probabilistic problem-solving
- Bayesian networks (inference and learning)
- Markov decision processes
5 Problem-solving using machine learning

Learning outcomes / competencies / targeted competencies:

- Be able to practically apply the basic procedures, methods and approaches of Artificial Intelligence.
- Professional competence, especially in the areas of search, logic, planning, machine learning.
- Master the terminology of the field.
- Be able to place the individual methods/approaches of AI in their overall context.
- Be able to place the subject area (or parts of the subject area) in the context of other disciplines.
- Be able to transfer basic methods to individual task situations and solve them.

Calculation of student workload:

56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English	Prof. Ph.D. Michael Beetz
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	6 / 180 hours

Module examinations

Module examination: Module exam

Type of examination: module exam

Form of examination: Announcement at the beginning of the semester	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch	
Description: Portfolio or Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Advanced Methods of AI	
Frequency: winter semester, yearly	**Are there parallel courses?** no
Contact hours: 4 hours	**University teacher:** Prof. Ph.D. Michael Beetz
Language(s) of instruction: Englisch	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-F-AML: Advanced Machine Learning
Advanced Machine Learning

Assignment to areas of study:	Content-related prior knowledge or skills:
• Foundations	Fundamentals of Machine Learning (or equivalent)

Learning content:
Generative/ discriminative models, regression, features, evaluation

- Statistical and mathematical fundamentals.
- Fundamentals of neural networks.
- Convolutional Neural Networks, Recurrent Neural Networks, Generative Models, Bayesian and Gaussian Networks.
- Attention Modules, Distance Metric Learning, Gradient Boosting.
- End-to-end Systems, Optimization, Explainable AI.
- Responsible use of computational resources and computational complexity of machine learning and deep neural networks.
- Concepts for handling data and model sharing, as well as for sharing hardware, software and infrastructure.

Learning outcomes / competencies / targeted competencies:

- The students will be able to weigh different methods of machine learning against each other for complex use cases.
- They will be able to describe the differences, advantages and drawbacks, and preconditions of different methods (including transfer).
- They are able to understand and explain the Python code for these methods.
- They are able to estimate the resource consumption of machine learning methods.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Dr. Tanja Schultz
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	6 / 180 hours

Module examinations

Module examination: Module exam

Type of examination: module exam

Form of examination: Announcement at the beginning of the semester	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch	
Description: Portfolio or Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Advanced Machine Learning	
Frequency: winter semester, yearly	**Are there parallel courses?** no
Contact hours: 4 hours	**University teacher:** Dr. Felix Putze Prof. Dr. Tanja Schultz
Language(s) of instruction: Englisch	
Literature: • Murphy, K. P. (2013). Machine learning: a probabilistic perspective. Cambridge, Mass. [u.a.]: MIT Press. ISBN: 9780262018029 0262018020 • Duda, R. O., Hart, P. E.,, Stork, D. G. (2001). Pattern Classification. New York: Wiley. ISBN: 978-0-471-05669-0 • Deep Learning by Goodfellow et al. (online at https://www.deeplearningbook.org/)	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-F-IIS: Integrated Intelligent Systems
Integrated Intelligent Systems

Assignment to areas of study:	Content-related prior knowledge or skills:
• Foundations	None

Learning content:
The module deals with current techniques for the implementation of technical cognitive systems, i.e. intelligent computer systems that have sensors and actuators. Such systems are mainly used in areas such as service robotics, smart homes, autonomous space probes, and driver assistance systems.

The following topics are covered:

- Sensors, actuators and the hardware infrastructure of technical cognitive systems, sensor models and noise.
- Basics of monocular and stereo computer vision.
- Control of technical cognitive systems: forward and inverse kinematics, dynamics.
- Basics of probabilistic state estimation: Bayesian filters, Kalman filters, particle filters, mechanisms for data association, learning of sensor and action models, hidden Markov models, expectation maximization.
- Applications of probabilistic state estimation: localization, environment mapping, object tracking.
- Programming methods for technical cognitive systems: rational agent models, concurrent reactive control, knowledge and plan-based control, learning-based agents.

In this module, ethical challenges are discussed that arise from the challenges posed by the development and use of artificial intelligence. The opportunities and possibilities of AI are also discussed, along with international initiatives currently undertaken by researchers and developers, such as the Ethical Aligned Design (IEEE), that aim to develop criteria for the responsible use of AI.

Learning outcomes / competencies / targeted competencies:
The students

- are familiar with the current techniques for implementing technical cognitive systems,
- can apply typical programming methods for technical cognitive systems,
- are familiar with possible application scenarios for technical cognitive systems,
- are able to assess and discuss ethical challenges arising from the development and use of artificial intelligence.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
no

Language(s) of instruction:	Responsible for the module:
English	Prof. Ph.D. Michael Beetz
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]

The module is valid since / The module is valid until:	Credit points / Workload:
WiSe 24/25 / -	6 / 180 hours

Module examinations

Module examination: Module exam	
Type of examination: module exam	
Form of examination: Announcement at the beginning of the semester	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch	
Description: Portfolio or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.	

Module courses

Course: Integrated Intelligent Systems	
Frequency: winter semester, yearly	**Are there parallel courses?** no
Contact hours: 4 hours	**University teacher:** Prof. Ph.D. Michael Beetz
Language(s) of instruction: Englisch	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-F-ATE: AI Algoriths: Theory and Engineering

AI Algorithms: Theory and Engineering

Assignment to areas of study:	Content-related prior knowledge or skills:
• Foundations	None

Learning content:

- Algorithmic Paradigms: Greedy, Divide-and-Conquer, Dynamic Programming.
- Abstract Machines, formal verification and runtime analysis.
- Fundamental graph algorithms.
- Linear Programming.
- Basic of Computational complexity theory and reduction.
- Fundamentals of propositional logic and predicate logic.
- Methods and tools for developing high-quality AI algorithms, including scalability, explainability, transparency, and robustness for varying operational conditions.
- Patterns, data structures, frameworks, advanced libraries, and infrastructure for implementing and deploying AI algorithms.
-

Learning outcomes / competencies / targeted competencies:

- Know the fundamental principles needed to design algorithms.
- Understand the basic concepts of abstract machines, formal verification and model checking.
- Master runtime analysis.
- Learn how to find the solutions to algorithmic problems, assess different approaches with regard to their efficiency and choose the most suitable approach.
- Know the basic complexity classes, such as PTime, NP and PSpace.
- Master the basics of propositional logic and predicate logic.
- Master advanced data structures, modern libraries, and frameworks for implementing efficient and effective AI algorithms, and package them into deployable components.
- Learn how to identify and analyze tradeoffs for designing and implementing AI-enabled components and integrating them into systems by assessing qualities beyond efficiency, such as operation cost, interpretability, and robustness.
- Learn how to design and implement fault-tolerant, scalable infrastructure for deploying AI-enabled components, including automated techniques for ensuring data quality, runtime performance, and provenance.
-

Calculation of student workload:

124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:	Responsible for the module:
English	N.N.

Frequency: winter semester, yearly	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 24/25 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Module exam	
Type of examination: module exam	
Form of examination: Announcement at the beginning of the semester	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch	

Module courses

Course: AI Algorithms: Theory and Engineering	
Frequency: winter semester, yearly	**Are there parallel courses?** no
Contact hours: 4 hours	**University teacher:** N.N.
Language(s) of instruction: Englisch	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-M-CER1: Cognition-Enabled Robotics 1
Cognition-Enabled Robotics 1

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Major/Minor / Compulsory	Advanced Methods of AI, Integrated Intelligent Systems.

Learning content:
The module content depends on the chosen course.

Learning outcomes / competencies / targeted competencies:
The students acquire, in a research-like environment, knowledge of a sub-field of *Cognition-Enabled Robotics*.

They will have studied (architectural) concepts, modeling procedures and/or algorithms and thus understood specific methods of an area of *Cognition-Enabled Robotics*. These can be used to develop software, which can then be applied to tasks in this field.

The exact outcomes depend on the selected course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Ph.D. Michael Beetz
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	6 / 180 hours

Module examinations

Module examination: Modul exam

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch / German (Depending on the selected course.)

Description:
Will be decided upon by the Lecturer of the specific course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Cognition-Enabled Robotics 1	
Frequency: each semester	**Are there parallel courses?** yes
Contact hours: 4 hours	**University teacher:** Lehrende der Informatik
Language(s) of instruction: Englisch / German (In addition to course alternatives in English there may be also alternatives in German.)	
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-M-MLCS1: Machine Learning and Cognitive Systems 1
Machine Learning and Cognitive Systems 1

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Major/Minor / Compulsory	Advanced Machine Learning

Learning content:
The module content depends on the chosen course.

Learning outcomes / competencies / targeted competencies:
The students acquire, in a research-like environment, knowledge of a sub-field of *Machine Learning and Cognitive Systems*.

They will have studied (architectural) concepts, modeling procedures and/or algorithms and thus understood specific methods of an area of *Machine Learning and Cognitive Systems*. These can be used to develop software, which can then be applied to tasks in this field.

The exact outcomes depend on the selected course.

Calculation of student workload:
124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?
yes

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Tanja Schultz
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	6 / 180 hours

Module examinations

Module examination: Module exam

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch / German (Depending on the selected course.)

Description:
Will be decided upon by the Lecturer of the specific course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Machine Learning and Cognitive Systems 1	
Frequency: winter semester, yearly	**Are there parallel courses?** no
Contact hours: 4 hours	**University teacher:** Lehrende der Informatik
Language(s) of instruction: Englisch / German (In addition to course alternatives in English there may be also alternatives in German.)	
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-M-CER2: Cognition-Enabled Robotics 2
Cognition-Enabled Robotics 2

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Major/Minor / Compulsory elective	Advanced Methods of AI, Integrated Intelligent Systems

Learning content:
The module content depends on the chosen course.

Learning outcomes / competencies / targeted competencies:
The students acquire, in a research-like environment, knowledge of a sub-field of *Cognition-Enabled Robotics*.

They will have studied (architectural) concepts, modeling procedures and/or algorithms and thus understood specific methods of an area of *Cognition-Enabled Robotics.* These can be used to develop software, which can then be applied to tasks in this field.

The exact outcomes depend on the selected course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Ph.D. Michael Beetz
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	6 / 180 hours

Module examinations

Module examination: Module exam

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch / German (Depending on the selected course.)

Description:
Will be decided upon by the Lecturer of the specific course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Cognition-Enabled Robotics 2	
Frequency: each semester	**Are there parallel courses?** yes
Contact hours: 4 hours	**University teacher:** Lehrende der Informatik
Language(s) of instruction: Englisch / German (In addition to course alternatives in English there may be also alternatives in German.)	
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-M-MLCS2: Machine Learning and Cognitive Systems 2
Machine Learning and Cognitive Systems 2

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• Major/Minor / Compulsory elective	Advanced Machine Learning

Learning content:
The module content depends on the chosen course.

Learning outcomes / competencies / targeted competencies:
The students acquire, in a research-like environment, knowledge of a sub-field of *Machine Learning and Cognitive Systems*.

They will have studied (architectural) concepts, modeling procedures and/or algorithms and thus understood specific methods of an area of *Machine Learning and Cognitive Systems*. These can be used to develop software, which can then be applied to tasks in this field.

The exact outcomes depend on the selected course.

Calculation of student workload:
56 h SWS / presence time / working hours
124 h Preparation / follow-up work

Are there optional courses in the modules?
yes

Language(s) of instruction:	**Responsible for the module:**
English / German	Prof. Dr. Tanja Schultz
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	6 / 180 hours

Module examinations

Module examination: Module exam

Type of examination: module exam

Form of examination:	**The examination is ungraded?**
Announcement at the beginning of the semester	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction:
Englisch / German (Depending on the selected course.)

Description:
Will be decided upon by the Lecturer of the specific course: Portfolio, Presentation + Research paper or Written/Oral Exam with, if applicable, bonus tasks throughout the semester.

Module courses

Course: Machine Learning and Cognitive Systems 2	
Frequency: each semester	**Are there parallel courses?** yes
Contact hours: 4 hours	**University teacher:** Lehrende der Informatik
Language(s) of instruction: Englisch / German (In addition to course alternatives in English there may be also alternatives in German.)	
Literature: The literature depends on the chosen course.	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-R-PJ: Master Project

Master Project

Assignment to areas of study:	Content-related prior knowledge or skills:
• Research	The prerequisite knowledge is project-specific.

Learning content:

The content is project-specific and can therefore not be described in general terms.

Learning outcomes / competencies / targeted competencies:
In the process of completing a project module, there are many outcomes that are achieved beyond the bounds of the specific task itself. In the *Master Project,* the focus is on developing an understanding of scientific culture and research practice. In addition to the specific Artificial Intelligence and Intelligent Systems related objectives for each project, meta-goals are also pursued: In accordance with the following list, each project should display competence throughout areas A, B and C, and from each of these, pursue several objectives including, in all cases, A1, B1, C1 and C6:

A Research practice and scientific culture:

1. Recognize and understand, within a practical context, the usefulness of specific scientific theories and methods.
2. Be familiar with the project-specific field of research and be able to research, understand and process the relevant literature.
3. Be familiar with professional networks, scientific organizations and cultures in the project-specific field (forums, conferences, professional societies, publications, etc.).
4. Be able to write their own scientific texts (documentation, project report, submissions to conferences, etc.).

B Development of professional systems:

1. Be able to apply software development methods in the context of a larger project.
2. Select and use programming languages and environments for a specific application field and be able to read and modify existing source code.
3. Be able to apply interactive design and user-centered design methods in the context of the project and to compare and evaluate different design concepts.
4. Be able to use methods of evaluation, testing, quality management and documentation.
5. Be able to recognize and understand the regulatory environment of the field (standards, certification, licensing, open source, etc.).

C "Soft Skills"

1. Understand the tasks and methods of project management and be able to apply them in the context of a larger project (planning, time and work organization, effort measurement, business plan, etc.).
2. Be able to analyze a variety of social, legal, economic and technical framework conditions and evaluate them in relation to the context of the project.
3. Be able to analyze, understand, discuss and evaluate the social responsibility of computer scientists within the project context, allowing for the analysis, understanding, discussion and evaluation of interests, ethical guidelines, ambivalences, etc.
4. Develop intercultural competence through the practical experience of undertaking the project.
5. Recognize different aspects of gender and implement an orientation of gender equality in practice.
6. Develop communicative competence (discussion skills, moderation, conflict management), through engaging in effective teamwork and also taking on leadership tasks.
7. Master presentation and public relations skills within both university and open forum environments.

Calculation of student workload:
600 h Preparation / follow-up work
120 h SWS / presence time / working hours

Are there optional courses in the modules?
yes

Language(s) of instruction: English / German	**Responsible for the module:** N.N.
Frequency: summer semester, yearly	**Duration:** 2 semester[s]
The module is valid since / The module is valid until: WiSe 24/25 / -	**Credit points / Workload:** 24 / 720 hours

Module examinations

Module examination: Module exam	
Type of examination: module exam	
Form of examination: Project report	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch / German (Depending on the selected project.)	

Module courses

Course: Master Project	
Frequency: summer semester, yearly	**Are there parallel courses?** yes
Contact hours: 6 hours	**University teacher:** Lehrende der Informatik
Language(s) of instruction: Englisch / German (In addition to project alternatives in English there may be also alternatives in German.)	
Literature: The literature depends on the project.	
Teaching method(s): Project	**Associated module examination:** Module exam

Module 03-INF-MA-R-MS: Master Seminar
Master Seminar

Assignment to areas of study:	Content-related prior knowledge or skills:
• Research	The prerequisite knowledge is seminar-specific.

Learning content:
Master's seminars are offered by different lecturers on various topics in the context of Artificial Intelligence and Intelligent Systems. The content of the module depends on the specific seminar chosen.

In general, the individual topics are discussed and agreed upon within the scope of the seminar itself. Material is then researched and prepared individually or in small groups, which is then presented to the other seminar participants along with a written scientific report. Special attention is paid to the scientific principles of research.

The presentations should be designed and didactically prepared to match the audience's prior knowledge, while questions and discussion should be considered as central components of a lively, effective seminar.

To begin the seminar, the Lecturer will generally give an introduction to the subject area and thus establish some initial connections between the individual presentation topics. This general view and the interconnections between the themes will become clearer and more detailed in the context of the discussions on the individual papers. At the end of the seminar, there is usually a summary of the topics covered during the semester.

Learning outcomes / competencies / targeted competencies:
- Understand and reflect on selected aspects of the subject through an extended research exploration;
- Independently research and prepare material on a defined sub-topic and be able to communicate it to others in an appropriate manner;
- Present content in a didactic manner and display the ability to moderate and reflect in the context of a self-designed seminar session;
- Understand scientific literature in terms of content and structure, while also being able to apply a basic knowledge of the requirements for scientific texts to the example of one's own seminar paper.

Calculation of student workload:
62 h Preparation / follow-up work
28 h SWS / presence time / working hours

Are there optional courses in the modules?
yes

Language(s) of instruction:	Responsible for the module:
English / German	N.N.
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	3 / 90 hours

Module examinations

Module examination: Module exam	
Type of examination: module exam	
Form of examination: Presentation and written assignment	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch / German (Depending on the selected seminar.)	

Module courses

Course: Master Seminar	
Frequency: each semester	**Are there parallel courses?** yes
Contact hours: 2 hours	**University teacher:** Lehrende der Informatik
Language(s) of instruction: Englisch / German (In addition to seminar alternatives in English there may be also alternatives in German.)	
Literature: A literature list will be announced at the start of the Seminar	
Teaching method(s): Seminar	**Associated module examination:** Module exam

Module 03-INF-MA-AI-R-R: Guided Research
Guided Research

Assignment to areas of study:	Content-related prior knowledge or skills:
• Research	The prerequisite knowledge depends on the specific topic chosen.

Learning content:
In this module, participants acquire the competences required for independent scientific work. The course focuses on teaching and testing the important aspects needed to pursue any future job positions in the area of computer science research, in particularly the ability to conduct independent research. In close coordination with a supervisor, a research question is developed and suitably worked on to produce a scientific paper.

The module content depends on the specific topic chosen.

Learning outcomes / competencies / targeted competencies:
Successful participation in the module enable participants to:

- Analyze a sub-area of computer science.
- Evaluate the methods and technologies used in a specific field of computer science.
- Independently conduct scientific literature research.
- Create and structure individual scientific texts in English.
- Structure results and present them in a short lecture.
- Successfully respond to feedback on individual performance.
- Find and discuss possible solutions to a variety of given tasks.
- Independently perceive possible problems as well as then discussing and coping with them (along with challenges presented by the supervisor).
- Reflect on own abilities and weaknesses.
- Consolidate and expand personal knowledge and develop a comfort with the use of a variety of research methods.
- Maintain enthusiasm for a research question/task over an extended period of time.

Calculation of student workload:
28 h SWS / presence time / working hours
152 h Self-study

Are there optional courses in the modules?
yes

Language(s) of instruction:	Responsible for the module:
English / German	Prof. Ph.D. Michael Beetz
Frequency: each semester	**Duration:** 1 semester[s]
The module is valid since / The module is valid until: WiSe 24/25 / -	**Credit points / Workload:** 6 / 180 hours

Module examinations

Module examination: Module exam	
Type of examination: module exam	
Form of examination: Assignment	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch / German	

Module courses

Course: Guided Research	
Frequency: each semester	**Are there parallel courses?** yes
Contact hours: 2 hours	**University teacher:** Lehrende der Informatik
Language(s) of instruction: Englisch / German	
Literature: • Deiniger, Lichter, Ludewig; Studienarbeiten: Ein Leitfaden zur Erstellung, Durchführung und Präsentation wissenschaftlicher Abschlussarbeiten am Beispiel Informatik; vdf Hochschulverlag AG an der ETH Zürich; 6. Edition (1. Mai 2017) Further literature will be announced at the start of the module.	
Teaching method(s): Self-study unit	**Associated module examination:** Module exam

Module 03-INF-MA-AI-S-CDF: Cross-Disciplinary Foundations
Cross-Disciplinary Foundations

Assignment to areas of study:	**Content-related prior knowledge or skills:**
• General Studies	None

Learning content:

In preparation for the projects starting in the 2nd semester of the master's program, this module aims to demonstrate and develop the necessary skills to successfully carry out such projects.

Partly in the form of lectures (including guest lectures from other scientific fields and the industry), partly in the form of seminar work or small group work, a bridge is built from assumed theoretical foundational knowledge and previous experiences to scientifically based project work and professional practice. The following topics will be covered in particular:

- Scientific practice (including research funding, proposals).
- Methodological aspects: Statistical procedures, visualization, experiments.
- Philosophy of science (e.g. Kuhn, Popper, Descartes).
- Scientific culture and research ethics.
- Interdisciplinary work and the far reaching applications of computer science.
- Project management: time and resource management (also using the example of medium-sized companies).
- Project management: motivation and leadership.
- Applications and curriculum vitae (also foreign applications).
- Moderation techniques and decision making.

Learning outcomes / competencies / targeted competencies:

- Consolidate and understand methods of project and time management.
- Have knowledge of and be able to discuss concepts of scientific theory.
- Be able to develop and write scientific proposals based on an example.
- Know and be able to understand the structure, content structure and methods for the master's thesis.
- Be able to discuss and evaluate ethical aspects of project and professional work.

Calculation of student workload:

124 h Preparation / follow-up work
56 h SWS / presence time / working hours

Are there optional courses in the modules?

no

Language(s) of instruction:	**Responsible for the module:**
English	Dr. rer. nat. Jörn Syrbe
Frequency:	**Duration:**
winter semester, yearly	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	6 / 180 hours

Module examinations

Module examination: Modul exam	
Type of examination: combination exam	
Form of examination: Announcement at the beginning of the semester	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 2 / - / -	
Language(s) of instruction: Englisch	
Description: Portfolio and Oral Exam.	

Module courses

Course: Cross-Disciplinary Foundations	
Frequency: winter semester, yearly	**Are there parallel courses?** no
Contact hours: 4 hours	**University teacher:** Dr. rer. nat. Jörn Syrbe
Language(s) of instruction: Englisch	
Literature: A literature list will be announced at the start of the module.	
Teaching method(s):	**Associated module examination:** Module exam

Module 03-INF-MA-AI-T-MT: Master Thesis
Master Thesis

Assignment to areas of study:	Content-related prior knowledge or skills:
• Master Thesis	The prerequisite knowledge depends on the specific topic chosen.

Learning content:
The module content depends on the specific topic chosen.

Learning outcomes / competencies / targeted competencies:
The outcomes depend on the specific chosen topic in the context of *Artificial Intelligence and Intelligent Systems*.

Meta-goals: Through the Master's thesis, the competences gained from the Master programme thus far are extended and explored in depth. In particular, the students have the ability to:

- Combine knowledge from different fields and to deal with an added layer of complexity.
- Use their own knowledge and understanding to design models, systems and processes.
- Apply innovative methods in solving the problems that arise.
- Contribute to the advancement of computer science as a scientific discipline.
- Formulate, formalize and solve problems within the context of a new and developing field.
- Develop their competency in scientific work and methodology (a prerequisite for a possible subsequent doctoral project).

Calculation of student workload:
872 h Self-study
28 h SWS / presence time / working hours

Are there optional courses in the modules?
yes

Language(s) of instruction:	Responsible for the module:
English	N.N.
Frequency:	**Duration:**
each semester	1 semester[s]
The module is valid since / The module is valid until:	**Credit points / Workload:**
WiSe 24/25 / -	30 / 900 hours

Module examinations

Module examination: Colloquium

Type of examination: module exam

Form of examination:	The examination is ungraded?
Colloquium	no

Number of graded components / ungraded components / prerequisites of the examination:
1 / - / -

Language(s) of instruction: Englisch

Module examination: Master thesis	
Type of examination: module exam	
Form of examination: Master Thesis	**The examination is ungraded?** no
Number of graded components / ungraded components / prerequisites of the examination: 1 / - / -	
Language(s) of instruction: Englisch	

Ergänzungen zu den einzelnen Modulbeschreibungen

Leider wird das Feld ,,Bemerkungen zu den Wahlmöglichkeiten der LVs“ in der pdf-Ausgabe des Modulhandbuchs derzeit nicht angezeigt (war vor einigen Wochen noch anders).

Für die Module mit LV-Wahlalternativen sind die folgenden Informationen in der Datenbank enthalten, wodurch insbesondere für die vier Major/Minor-Module und das Master-Seminar die eigentlichen fachlichen Inhalte zugreifbar werden (aktuelle LV-Liste und Verweis auf Webseite mit LV-Beschreibungen).

Module 03-INF-MA-AI-M-CER1/2 (Cognition Enabled Robotics 1/2)

Students are given the choice of a wide variety of courses offered in this module, for example:

- Software Engineering for Cognitive Robots.
- Game Engines in AI.
- Human-Centered Interaction in Robotics.
- Trustworthy Cognitive Robots and Systems.
- Semantic 3D Perception for Robotic Systems.
- Introduction to Intelligent Marine Systems.
- Robot Programming with ROS.
- AI - Knowledge Acquisition and Knowledge Representation.
- Current Topics in Human Computer Interaction.
- Menschliches and maschinelles Lernen und Verstehen

Which specific courses are offered is dependent on available staff capacities and can be found in the semester plans and Course Catalogs.

You can find a brief overview of each of the courses at:
https://lvb.informatik.uni-bremen.de/ai-m-cer

Module 03-INF-MA-AI-M-MLCS1/2 (Machine Learning and Cognitive Systems 1/2)

Students are given the choice of a wide variety of courses offered in this module, for example:

- Life-long Machine Learning
- Automatische Spracherkennung
- Interpretable Machine Learning
- Good Practice in Machine Learning Research
- Cognitive Modeling
- Gehirn-Muster-Erkennung
- Deep Learning und 3D Bildverarbeitung
- Umgang mit unsicherem Wissen
- Bioninspirierte Mustererkennung und Szenenanalyse
- Reinforcement Learning
- Machine Learning for Autonomous Robots

Which specific courses are offered is dependent on available staff capacities and can be found in the semester plans and Course Catalogs.

You can find a brief overview of each of the courses at:
https://lvb.informatik.uni-bremen.de/ai-m-mics

Modul 03-INF-MA-AI-R-PJ (Master Project)

Students are able to select from a list of specific Master's projects offered to their respective year group.

Modul 03-INF-MA-AI-R-MS (Master Seminar)

Students are given the choice of a wide variety of seminar topics, for example:

- Seminar on Autonomous and Intelligent Systems.
- Ausgewählte Probleme kognitiver Systeme.
- Ausgewählte Probleme der multisensorischen Kognition.
- Deep Learning für Medizinische Bildbearbeitung.
- Intelligente Umgebungen für die alternde Gesellschaft
- Seminar on Topics in Robot Software Engineering.
- Hot Topics in Sensors and Human Activity Research.
- Soft Computing.

You can find a brief overview of each of the seminars at:
https://lvb.informatik.uni-bremen.de/ai-r-ms

Modul 03-INF-MA-AI-R-R (Guided Research)

The individual thematic focus will be discussed and agreed upon with the respective supervisor(s).