Technische Hochschule Ingolstadt

Module handbook

Artificial Intelligence (SPO WS 22/23)

Master

Faculty of Computer Science

Study and examination regulations: WS 22/23

Status: 2024-02-06

Contents

1 Overview

Name of the study program	Artificial intelligence
Type of study & degree level	Consecutive, M.Sc. (Master of Science), full-time
First start date	Summer semester 2025, start every semester
Standard period of study	3 semesters, 90 ECTS, 46 semester hours per week
Place of study	THI, Ingolstadt
Language/s of instruction	English; individual modules can be offered in German
Cooperation	None; dual studies are possible
Admission requirements	Bachelor's degree in AI, Data Science, Computer Science or comparable with at least 210 ECTS, as well as successful participation in the aptitude test (proof of secure basic skills in the field of AI / Data Science / Machine Learning), see §3 & §4 of the study and examination regulations Artificial Intelligence
Capacity	30 students per academic year
Program Director	Prof. Dr. Sören Gröttrup E-Mail: Soeren.Groettrup@thi.de Phone:+49 (0) 841 / 9348-2332
Student advisor	Prof. Dr. Sören Gröttrup E-Mail: Soeren.Groettrup@thi.de Phone:+49 (0) 841 / 9348-2332

2 Introduction

This module handbook describes the current status of the courses offered in the Master's degree program in Artificial Intelligence in accordance with the Study and Examination Regulations (SPO) WS 2022/23. In particular, the module handbook specifies the study objectives and content of the individual compulsory modules as well as the division of the semester hours per week per module and semester. It also contains more detailed provisions on course-related performance and attendance assessments. In the event of ambiguities, the higher-level study and examination regulations take precedence.

2.1 Objective

The Master's degree program in Artificial Intelligence builds on a Bachelor's degree in Artificial Intelligence, Data Science or a related field.

It deepens scientific knowledge and skills with regard to the development and conception of the latest methods and concepts of artificial intelligence. It enables graduates to independently design, implement and apply AI solutions in terms of data management and algorithms for a wide range of practical and research issues and to evaluate these in terms of security aspects. The course enables them to work independently in the field of development and application of artificial intelligence. It also sharpens their awareness of the influence of artificial intelligence on society and the changes it brings. The detailed study objectives are listed in section 3.2 (or in relation to the subject areas in section 3.2.1).

In connection with these subject and topic-related competencies, the competencies described in a
The methodological, social and personal skills typically taught in the above-mentioned Bachelor's degree program are deepened and expanded.

2.2 Admission requirements

The course-specific admission and qualification requirements are regulated in §3 of the study and examination regulations of the Master's degree course. These are

- Proof of successful completion of a degree program at a German university with at least 210 ECTS credits or equivalent in the field of artificial intelligence, data science, computer science, mathematics, engineering, computer linguistics or a related field or an equivalent successful domestic or foreign degree.
- Successful participation in the aptitude test of the degree program, in which subject-specific aptitude (i.e. knowledge of mathematics, statistics, programming, as well as skills in the areas of machine learning, deep learning, computer vision, speech and text comprehension and big data technologies), independent scientific work and practical experience in the development of artificial intelligence applications are assessed. The details of the aptitude test are regulated in §4 of the study and examination regulations of the master's degree program.

Overarching regulations independent of the degree program are laid down in the respective superordinate regulations and statutes of Ingolstadt University of Applied Sciences (framework examination regulations, general examination regulations, matriculation statutes)[1] .

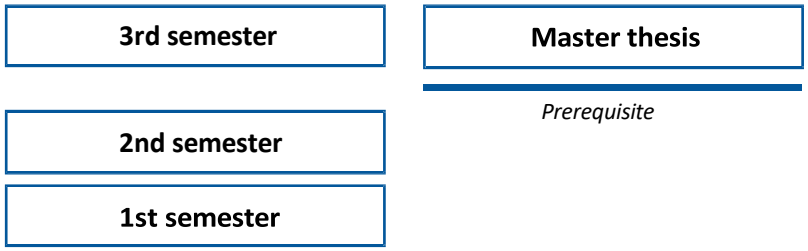
2.3 Target group

This Master's degree program is aimed at Bachelor's graduates in Artificial Intelligence, Data Science or related computer science courses who have a solid background in artificial intelligence, machine learning or data science and want to expand and deepen their skills (acquired in their Bachelor's degree) in the field of artificial intelligence, conception and development, as well as the provision of artificial intelligence solutions in various practical and research contexts. The target group in the narrower sense are in particular graduates of the Bachelor's degree programs in Artificial Intelligence, Computer Science, Business Informatics and Flight and Vehicle Informatics at Ingolstadt University of Applied Sciences.

[1] Available at https://www.thi.de/en/university/university-profile/university-management/legal-department/general-statutes/

2.4 Study structure

The standard period of study for the Master's degree course in Artificial Intelligence comprises three semesters, as shown in the following diagram.



The 3rd semester is intended for the preparation of the Master's thesis. The contents of the modules of the
Semester 1 and semester 2 (and vice versa) are independent of each other. They do not build on each other. This ensures that it is possible to start this Master's degree program in both the summer and winter semesters. Some of these compulsory modules are defined as subject-specific compulsory elective modules, i.e. the number and scope of these modules is mandatory, while the specific subject-specific modules can be chosen from a wider range of elective modules. Details on this are listed in the following sections.

2.4.1 Compulsory modules

The following table contains the modules of the first two semesters of the Master's degree course in Artificial Intelligence, including their key dates and semester allocation.

No.	Module	Summer semester		Winter semester	
		SWS	CP	SWS	CP
1	Advanced Computer Vision			4	5
2	Deep learning Applications			4	5
3	Advanced Speech Technology	4	5		
4	Advanced Big Data Concepts and Technologies			4	5
5	Intelligent Robotics			4	5
6	Social Implications of Artificial Intelligence	4	5		
7	AI in Safety-related Systems	4	5		
8	Elective 1	4	5		
9	Elective 2			4	5
10	Interdisciplinary Elective			4	5
11	Seminar	2	3		
12	Project	4	7		
	Total	**22**	**30**	**24**	**30**

Legend:

CP	Credit Points (ECTS points)
SWS	Semester hours per week

2.4.2 Subject-specific elective modules

The first two semesters of the Master's degree course in Artificial Intelligence include a total of three elective modules. These can be selected from the course's elective module catalog. This is determined for each semester and announced in the curriculum for the respective semester.

Compulsory modules from other Master's degree programs, like AI Engineering of Autonomous Systems, Business Information Systems Engineering and Cloud Applications und Security Engineering are offered as elective modules in the Artificial Intelligence degree program, according to their annual offering cycle. These modules give students the opportunity to extend the skills taught in the compulsory modules of their degree program in the direction of other extremely topical and sought-after subject areas. In addition to these elective modules, further elective modules matching the

content profile of the degree program may be offered. Such elective modules can only be offered if there is a sufficient number of participants.

For the interdisciplinary elective module, non-technical modules from other disciplines must be selected. The modules offered for this are typically compulsory or elective modules from other Master's degree programs in other faculties at THI, e.g. the Business School.

The selection of elective modules via online subject registration takes place at the beginning of the semester, usually in the first week of the semester. This serves to determine demand and, if necessary, to ensure an appropriate distribution of demand among the elective modules. There is no entitlement to participate in certain elective modules offered in a semester. The opportunity to participate in the number of elective modules planned per semester is ensured (see semester allocation according to the table in section 2.4.1).

2.5 Dual study program

In cooperation with selected practice partners, the degree course can also be completed in the dual study model ("study with in-depth practice"). Dual students work in the cooperating company during the lecture-free period and can thus supplement the theoretical knowledge they have acquired during their studies with professional practice. An optimal integration of theory and practice is guaranteed by the quality standards of "hochschule dual", the umbrella brand for dual studies in Bavaria (https://www.hochschule-dual.de/en/).

The lecture times in the dual study model correspond to the study and lecture times at the THI. The curriculum of the dual study model differs from the non-dual study program concept in the following points:

- **Dual modules**: Elective modules particularly suitable for dual students are offered on a regular basis. These courses are held at the university or at a dual partner. Projects particularly suitable for dual students are also offered. It is possible to receive credit for projects based on skills acquired outside the university from the company as a place of learning. Where possible, individual courses are held by lecturers from the partner companies.
- **Final thesis at the partner company**: In the dual study model, the final thesis is written at the cooperation company, usually on a practice-related topic.

Organizationally, the dual study program model is characterized by the following components:

- **Mentoring**: The central contacts for dual students in the faculty are the respective program directors. They organize an annual mentoring meeting with the dual students of the respective degree course.
- **Quality management**: The evaluations and surveys at THI for quality assurance of the degree programs include separate blocks of questions for the dual study program.
- **"Forum dual"**: Organized by the THI Career Service and Student Advisory Service (CSS), the "Forum dual" takes place once a year. This promotes the professional and organizational exchange between the dual cooperation partners and the faculty and serves to ensure the quality of the dual study programs. All cooperation partners in the dual study program as well as representatives and dual students of the faculty are invited to the event.

Further information on the dual Master's program can be found at https://www.thi.de/en/studies/degree-programmes/dual-studies/master-dual/

Formal legal regulations for dual studies for all degree programs at THI can be found in the APO[2] (see §§ 17 (3) and 30 (5)) and the matriculation statutes[3] (see §§ 8b, 9 and 18).

2.6 Concept

The Master's degree course in Artificial Intelligence was developed as an independent degree course with a clear focus on the increasingly relevant topic of artificial intelligence as part of the further development of the Master's degree courses at the Faculty of Computer Science. The content and orientation of the Artificial Intelligence degree program (see sections 2.1 and 3.2.1) was designed with a view to companies (both regional and supraregional) and scientific institutions, such as the AI research institute AImotion Bavaria, which is affiliated with the THI, highly sought-after competencies, as well as taking into account a competitive analysis of the computer science-related Master's degree programs offered at Bavarian universities of applied sciences.

A Master's degree course in Artificial Intelligence was also urgently requested and demanded by students on the Bachelor's degree course in Artificial Intelligence and other Bachelor's degree courses in the Faculty of Computer Science at THI.

[2] General Examination Regulations of THI, available at https://www.thi.de/en/university/university-profile/university-management/legal-department/general-statutes/

[3] Ibid.

3 Qualification profile

3.1 Mission statement

The degree program takes up the mission statement of teaching ("Personalities for a future worth living"[4]) at Ingolstadt University of Applied Sciences in the following way:

"We prepare our students for the challenges of the future":

- The course focuses on the topic of artificial intelligence (see section 2.1), which is of fundamental importance for companies and whose importance will continue to increase in the future due to the constant advance of digitalization and newly emerging applications of artificial intelligence. In the associated modules, the current state of the art established in the field is taught and classified.
- Wherever possible, the modules of the degree course highlight the influences of current or emerging social, economic and research-relevant trends on the topics covered in the degree course, as well as the associated challenges for companies, in order to sensitize students to changes in the framework conditions of their future careers.

"We enable our students to develop solutions to problems on the basis of scientific findings."

- In terms of content and methodology, the modules of the degree program demonstrate the current state of the art in the field and illustrate its practical applicability.
- The application of scientific knowledge to solve problems is taken into account in the design and implementation of the various modules:
    - In the project: The consideration of the current state of scientific and methodological knowledge is an essential aspect in the processing of the task.
    - In the seminar: The classification of the seminar topic to be worked on in the current state of scientific knowledge relevant to the topic is a fundamental step in the well-founded processing of a seminar topic.
    - In the other modules: The integration of suitable tasks and practical exercises promotes the application and transfer of the scientific topics covered in the modules.

[4] Available at https://www.thi.de/en/university/university-profile/mission-statement/principles-of-teaching/

"We open up outstanding regional and international perspectives for our students":

- The project groups offered in the degree program can be carried out by lecturers from companies in the region in addition to research-related professors. This gives students contact with industry and allows them to deal with current tasks from business practice. Lecturers can also be involved in other modules with a high practical relevance.
- Individual modules of the degree program are taught in English, which gives students the opportunity to interact in an international context and gain experience in this regard.
- The elective modules integrated into the curriculum give students the freedom to complete a semester abroad, as modules that are compatible with the profile or objectives of the degree program and that were completed abroad can generally be credited as elective modules.
- The specific subject areas and skills taught on the degree course (see section 3.2.1) are in high demand in almost all companies (regional, national and international) in view of the continuous advance of digitalization, digital transformation and developments in the field of artificial intelligence.

"We teach and learn through personal exchange":

- The lecturers demand and encourage an open and reflective exchange with the students in the context of teaching the module-specific topics and skills.
- Personal exchange is an integral part of the seminar and project modules in particular and plays a central role in these modules, both between the lecturer and the students and between the students themselves.
- In addition to working on a content-related task, modules with practical work and the project serve essentially to gather or deepen experience with regard to the various facets of cooperation in a team: individual work vs. working in (sub)groups of different sizes, coordination / synchronization between subgroups to achieve an overarching work goal, etc.

"We help all students to discover and exploit their individual potential."

- The range of thematic options (topics of the elective modules, project topics or seminar topics) helps students to become explicitly aware of their interests and preferences in terms of content.

- The need to occupy different roles when working on larger, more complex tasks in teams or projects and to work together in these roles encourages students to become aware of their preferred roles and the skills required for these roles.
- The students are actively informed by the course management about the extracurricular, comprehensive offerings of the THI with regard to entrepreneurship and the support and promotion of start-ups in order to initiate corresponding thought processes in this direction.

3.2 Study objectives

3.2.1 Subject-specific competencies of the degree program

The course content was defined according to the needs of companies and research institutions, as well as the qualification framework for German university degrees. Graduates of the Master's degree program in Artificial Intelligence are able to,

- independently design and implement the latest artificial intelligence algorithms and apply them to practical and research issues.
- adapt, construct and train deep neural networks of different types to existing tasks and data.
- find and implement artificial intelligence solutions for problems in various applications (including image, speech and text comprehension).
- design and set up efficient and scalable database architectures for a wide range of data types and large data volumes.
- develop and analyze AI applications with regard to security aspects.
- reflect on the impact of artificial intelligence on society and the economy, also with regard to ethical issues, and classify the opportunities and risks.

3.2.2 Interdisciplinary competencies of the degree program

In addition to the subject-related skills, the following interdisciplinary skills are taught or strengthened (building on the skills usually taught in a Bachelor's degree course).

Methodological skills:

Graduates of the degree program are able to,

- Analyze problems, recognize overarching relationships, apply principles and methods to solve problems, evaluate solutions and solution options conceptually and technically, and create decision papers.
- to work scientifically.

Social skills:

Graduates of the degree program are able to,

- work on complex tasks in a team in a goal-oriented manner (communication and teamwork skills).
- represent work results to third parties in a well-founded and comprehensible manner.
- to plan, organize and exercise leadership.
- to conduct a scientific discourse.

Self-competencies:

Graduates of the degree program are able to,

- to organize themselves.
- to communicate and present.
- to develop complex relationships independently.
- to think analytically and solution-oriented.
- to work in a goal-oriented and independent manner.
- to make well-founded decisions.
- structure and control projects (time management).

3.2.3 Examination concept of the degree program

When developing the degree program, care was taken to ensure that different forms of examination are used and that the forms of examination are suitable or appropriate for the content and skills taught in the modules.

The assignment of the examination forms to the individual modules is listed in the following table (see appendix to the study and examination regulations for the Master program Artificial Intelligence WS 2022/23):

No.	Module	Form of examination
1	Advanced Computer Vision	schrP
2	Deep learning Applications	prA
3	Advanced Speech Technology	schrP
4	Advanced Big Data Concepts and Technologies	schrP
5	Intelligent Robotics	prA
6	Social Implications of Artificial Intelligence	mdlP
7	AI in Safety-related Systems	schrP
8	Elective 1	LN
9	Elective 2	LN
10	Interdisciplinary Elective	LN
11	Seminar	SA
12	Project	PA
13	Master Thesis	MA

Legend:

schrP	written examination	The written examination is a written exam lasting 90 minutes unless explicitly stated otherwise.
mdlP	Oral examination	The oral examination is a questioning of 20-30 minutes per person, unless explicitly stated otherwise.
prA	Practical work	Practical work is a concrete task that is carried out in a practical setting. The task may consist of several subtasks. The assignments are to be completed either in a group or individually. In the case of group work, each student must contribute individually. The workload for the individual contribution corresponds to 125 hours. Depending on the type of assignment, the work result must be provided in a suitable form, e.g. source code or documentation. The work result must be explained by the group or the student in an acceptance meeting (scope of the acceptance meeting: 15 to 30 minutes for individual tasks, 30 to 60 minutes for group work,

		whereby in the acceptance meeting each group member must contribute to the parts of the results for which he/she is responsible). Further details can be found in the curriculum.
SA	Seminar paper	The seminar paper is a term paper with an oral presentation. The length of the term paper is approx. 8 to 15 pages (without cover pages, lists and appendices), created with a word processing program. The oral presentation lasts 45 to 75 minutes and can also take place during the semester.
PA	Project work	Project work is group work in which several students work on a joint task as a team over the course of a semester. Each student must contribute individually to the joint task. The workload for the individual contribution of each student corresponds to 175 hours. Depending on the nature of the task, the project result must be provided in a suitable form, e.g. source code or documentation, and the result (or interim results achieved at project milestones) must be presented orally, e.g. in regular project meetings or in a specialist presentation of the results lasting approx. 15 to 30 minutes. Further details can be found in the curriculum.
MA	Master thesis	Written thesis in the Master's program. The scope is approx. 60 to 100 pages (excluding cover sheets, indexes and appendices), created with a word processing program.
LN	Proof of performance	The proof of performance (LN) can be a written examination (schrP), an oral examination (mdlP), a practical thesis (prA) or a seminar paper (SA). The details will be determined by the Faculty Council in the curriculum.

3.2.4 Applied relevance of the degree program

The degree program was developed with a view to the topic of artificial intelligence and the associated skills that are in demand in practice and research (see sections 2.6 and 3.2.1). In addition to these, social and personal skills that are important for a professional career are also taken into account and deepened (see section 3.2.2). The project deals with typical, realistic tasks from company practice or research-related topics. This is usually supervised by professors from the AImotion AI research institute or lecturers from companies. The Master's thesis can be completed as a scientifically oriented university thesis, also in cooperation with the university-affiliated AImotion research institute, but also as an application-oriented thesis in a company.

3.2.5 Contribution of individual modules to the study objectives

The following table lists the modules of the degree program with the degree of their contribution to the subject-related study objectives of Artificial Intelligence (AI) as well as to the interdisciplinary methodological (MC), social (SoC) and personal skills (PeC) (see section 3.2.1 and section 3.2.2).

No.	Module	AI	MC	SoC	PeC
1	Advanced Computer Vision	++	+	+	+
2	Deep learning Applications	++	+	+	+
3	Advanced Speech Technology	++	+	+	+
4	Advanced Big Data Concepts and Technologies	++	+	o	o
5	Intelligent Robotics	++	+	+	+
6	Social Implications of Artificial Intelligence	++	+	+	+
7	AI in Safety-related Systems	++	+	o	o
8	Elective 1	*	*	*	*
9	Elective 2	*	*	*	*
10	Interdisciplinary Elective	*	*	*	*
11	Seminar	*	++	++	++
12	Project	*	++	++	++
13	Master Thesis	*	++	+	++

Legend:

- ++ High contribution to competence
- + Contribution to competence
- o No significant contribution to competence
- * For the project or seminar, the contribution to the subject-related competencies depends on the choice of topic. For the elective modules, the contribution to all competencies depends on the content-related topic or focus of the elective module and its design with regard to the interdisciplinary competencies. For the interdis. elective module, it is not possible to make a detailed statement regarding competencies.

3.3 Possible occupational fields

The field of artificial intelligence is becoming increasingly important or already plays a decisive role in many industries and companies with a wide range of applications. Graduates of the degree program can therefore work in companies of various sizes and in different industries. Typical job and role descriptions in companies in this context are:

- Data Scientist
- Machine Learning Engineer
- Deep Learning Engineer
- NLP Engineer
- AI Developer / Architect
- Big Data Engineer/ Architect

Graduates' future fields of activity focus on the following sectors (among others):

- Automotive industry (driver assistance systems, autonomous driving).
- Companies and employers in every industry in which artificial intelligence methods and techniques are developed and used.

Graduates have opportunities to work as self-employed or as employees in companies that primarily deal with the research, development and operation of artificial intelligence.

Graduates of the degree program are qualified to start a scientific career in this field. As an alternative, they can also work at a research institution with a focus on and application of artificial intelligence.

4 Module descriptions

4.1 General compulsory subjects

Advanced Computer Vision			
Module abbreviation:	KIM_AdvCV	**SPO no:**	1
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	2
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	winter semester only
Module supervisor(s):	Schön, Torsten		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total expenditure: 125 h		
Courses of the module:	Advanced Computer Vision		
Teaching forms of the module:	SU/Ü - seminar lessons/exercise		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examination performance:			
schrP90 - written exam, 90 minutes Further explanations: None			
Requirements according to SPO:			
None			
Recommended prerequisites:			
The following basics should be available from the Bachelor's program already completed: Programming language Python, AI frameworks (PyTorch, TensorFlow), machine learning and deep learning, computer vision, convolutional neural networks, architectures for classification, object recognition, semantic segmentation, human pose estimation, generative adversarial networks, pattern recognition.			
Intended learning outcomes:			

The aim of this module is to introduce students to advanced computer vision methods and deep learning architectures in line with the latest research findings. To this end, students deal with the processing of 2D and 3D image data and their fusion in different application areas. Students also learn how to transfer training successes to other data distributions using transfer learning, e.g. from data from a simulation to real data.

One of the latest concepts in computer vision is the application of attention mechanisms. In this module, students learn the basic concepts of the attention mechanism and transformer networks and how they can be applied to computer vision problems.

After successfully completing this module, students will be able to

- reconstruct 3D models from stereo or moving images.
- process and merge sensor data from different models.
- data in simulations and to transfer trained models to real data.
- process video data and make predictions based on it.
- register multimodal data.
- analyze decision-making processes within the networks.
- Attention and Transformer architectures to computer vision problems.
- Understanding and applying foundation models.
- extract, summarize and reproduce information independently from scientific publications.
- work on problems together in learning groups and reflect on their own approach.

Contents:

- Stereo vision and 3D reconstruction and depth estimation
- Processing sensor data from camera, LiDAR and radar
- Early, Late and Deep Fusion
- Video processing for tracking and intention recognition
- Optical Flow
- (visual) SLAM
- Registration of multimodal data
- Explainable AI (XAI)
- Attention / Self-Attention in Computer Vision
- Transformer-based models (Introduction to Transformers, Vision Transformers, Anchor-Box-Free Object Detection)
- Foundation Models
- Diffusion Models

Literature:

- RUSSELL, Stuart J. and Peter NORVIG, 2022. *artificial intelligence: a modern approach*. f. Edition. Harlow, United Kingdom: Pearson. ISBN 978-1-292-40113-3, 1-292-40113-3
- GOODFELLOW, Ian and others, 2018. *Deep Learning: the comprehensive handbook: basics, current methods and algorithms, new research approaches*. 1st edition. Frechen: mitp. ISBN 978-3-95845-700-3
- ZHANG, Xinyu, LI, Jun, LI, Zhiwei, LIU, Huaping, ZHOU, Mo, WANG, Li, ZOU, Zhenhong, 2023. *Multi-sensor Fusion for Autonomous Driving* [online]. Singapore: Springer Nature Singapore PDF e-Book. ISBN 978-981-9932-80-1. Available at: https://doi.org/10.1007/978-981-99-3280-1.
- SJAFRIE, Hanky, 2020 *Introduction to self-driving vehicle technology*. Boca Raton; London; New York: CRC Press. ISBN 9781000711776
- SZELISKI, Richard, 2022. *computer vision: algorithms and applications* [online]. Cham: Springer PDF e-Book. ISBN 978-3-030-34372-9. Available at: https://doi.org/10.1007/978-3-030-34372-9.

Notes:

No comments

Deep learning Applications			
Module abbreviation:	KIM_DLAnw	**SPO no:**	2
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	2
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	winter semester only
Module supervisor(s):	Schön, Torsten		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total expenditure: 125 h		
Courses of the module:	Deep learning Applications		
Teaching methods of the module:	SU/Ü - seminar lessons/exercise		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examination performance:			
prA - Practical work incl. acceptance interview of 30 min. Further explanations: None			
Requirements according to SPO:			
None			
Recommended prerequisites:			
The following basics should be available from the Bachelor's program already completed: programming language Python, AI frameworks (PyTorch, TensorFlow), machine learning and deep learning			
Intended learning outcomes:			

In this module, students learn about the safe application of deep learning methods for solving current research and development questions and apply this knowledge in a seminar paper. The aim of this module is to learn the necessary steps of data pre-processing and preparation, targeted parameterization of deep learning networks and scientific analysis of the training results and to apply them in practice. To this end, students gain an insight into the latest research fields and results and learn how to process them independently.

After successfully completing this module, students will be able to

- ideally prepare and augment data for use in deep learning models.
- to calibrate models ideally and train them in a targeted manner.
- monitor and correctly interpret the results and learning progress of the models.
- to deal with deep reinforcement learning environments.
- to specifically influence the training of deep learning models.

- draw the right conclusions from the training results and adjust the data or models accordingly.
- to deal with MLOps pipelines in order to ensure a high-quality standard in working with deep learning and to make it comprehensible.
- evaluate the results scientifically and present them in written and oral form.
- extract, summarize and reproduce information independently from scientific publications.
- work on problems together in learning groups and reflect on their own approach.

Contents:

- Data pre-processing and augmentation
- Dealing with incomplete and inhomogeneous data
- Active Learning
- Multiple Instance Learning
- Model calibration and reliability
- Deep reinforcement learning frameworks
- Model monitoring (e.g. tensor board)
- Machine Learning Operations (MLOps)
- Efficient network architectures for application on target hardware
- Scientific evaluation and processing of DL results
- Independent work on a topic in the form of a seminar paper

Literature:

- GOODFELLOW, Ian and others, 2018. *Deep Learning: the comprehensive handbook: basics, current methods and algorithms, new research approaches*. 1st edition. Frechen: mitp. ISBN 978-3-95845-700-3
- PLAAT, Aske, 2022. *deep reinforcement learning* [online]. Singapore: Springer PDF e-Book. ISBN 978-981-1906-38-1. Available at: https://doi.org/10.1007/978-981-19-0638-1.
- RUSSELL, Stuart J. and Peter NORVIG, 2022. *artificial intelligence: a modern approach*. f. Edition. Harlow, United Kingdom: Pearson. ISBN 978-1-292-40113-3, 1-292-40113-3
- BILGIN, Enes, December 2020. *Mastering Reinforcement Learning with Python: build next-generation, self-learning models using reinforcement learning techniques and best practices*. 1st edition. Birmingham; Mumbai: Packt. ISBN 978-1-83864-414-7

Notes:

No comments

Advanced Speech Technology

Module abbreviation:	KIM_SprachasSyst	**SPO no:**	3
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	1
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	summer semester only
Module supervisor(s):	Georges, Munir		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total expenditure: 125 h		
Courses of the module:	Advanced Speech Technology		
Teaching forms of the module:	SU/Ü - seminar lessons/exercise		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		

Examination performance:

schrP90 - written examination, 90 minutes

Further explanations:
None

Requirements according to SPO:

None

Recommended prerequisites:

The following basics should be available from the Bachelor's program already completed: programming language Python, machine learning and deep learning, language models, digital signal processing.

Intended learning outcomes:

After successfully completing the module courses, students will be able to

- to evaluate selected methods in voice assistants.
- analyze current developments in this area.
- apply methods and carry out experiments independently.
- research results in the context of voice assistance systems.
- applications and to further develop selected methods.
- Use speech/text algorithms to solve problems.
- extract information independently from scientific publications, summarize it and present it to groups.

Contents:
• Voice assistance systems • Speech recognition • Language/text comprehension • Knowledge (representation) • Text generation • Speech synthesis • Voice Biometrics (Emotions) • Efficient calculation and storage
Literature:
• EISENSTEIN, Jacob, 2019 *Introduction to natural language processing*. Cambridge, MA: The MIT Press. ISBN 978-0-262-04284-0, 0262042843 • GOODFELLOW, Ian, Yoshua BENGIO and Aaron COURVILLE, 2016. *deep learning*. Cambridge, Massachus- setts; London, England: The MIT Press. ISBN 978-0-262-03561-3 • JURAFSKY, Dan and James H. MARTIN, October 16, 2019. *speech and language processing*. 3rd edition. Stanford: Stanford University. ISBN https://web.stanford.edu/~jurafsky/slp3/
Notes:
No comments

Advanced Big Data Concepts and Technologies

Module abbreviation:	KIM_BigDataKonz	**SPO no:**	4
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	2
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	winter semester only
Module supervisor(s):	Cato, Patrick		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total expenditure: 125 h		
Courses of the module:	Advanced Big Data Concepts and Technologies		
Teaching forms of the module:	SU/Ü - seminar lessons/exercise		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		

Examination performance:

schrP90 - written exam, 90 minutes

Further explanations:
None

Requirements according to SPO:

None

Recommended prerequisites:

The following basics should be available from the Bachelor's program already completed: Relational database systems, SQL, non-relational data management systems.

Intended learning outcomes:

After successfully completing the module, students will be familiar with advanced concepts and technologies for storing and processing large amounts of data, i.e. they will be able to

- are able to explain the characteristics of big data and are familiar with basic and advanced concepts for processing and storing large amounts of data.
- are familiar with modern data management concepts and are able to independently design customized solution architectures for defined use cases.
- are familiar with various options for processing and analyzing data streams.
- have an understanding of the methods and tools of MLOps with a focus on data versioning.
- learn about current trends and technologies for storage, processing and analysis (e.g. stream processing in a big data context, data lake architectures).

Contents:

- Introduction: Definition of big data, selected use cases, data types, data formats and technology overview
- Distributed file systems: CephFS, HadoopFS
- Online analytics and stream processing (e.g. Apache Flink and Flink SQL)
- Non-relational data management systems for the management of large amounts of data (e.g. Elasticse arch)
- Synchronization process (timestamping, multi-version process, etc.)
- Big data processing and Kubernetes
- Conception of data pipelines
- Concepts and technologies for data management (data lake, delta lake, data mesh architecture)

Literature:

- DEHGHANI, Zhamak, 2022 *Data Mesh: Delivering Data-Driven Value at Scale*. Sebastopol, CA: O'Reilly Media. ISBN 978-1492092391
- KLEPPMANN, Martin, 2019. *designing data-intensive applications: concepts for reliable, scalable and maintainable systems.* ISBN 978-3960090755
- PERKINS, Luc, Eric REDMOND and Jim WILSON, 2018. *Seven databases in seven weeks: a guide to modern databases and the NoSQL movement*. ISBN 978-1-68050-253-4
- STRENGHOLT, Peter, 2020 *Data Management at scale: Best Practices for Enterprise Architecture*. ISBN 978-1492054788

Notes:

No comments

Intelligent Robotics

Module abbreviation:	KIM_IRobot	**SPO no:**	5
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	2
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	winter semester only
Module supervisor(s):	Schweiger, Johann		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total expenditure: 125 h		
Courses of the module:	Intelligent Robotics		
Teaching forms of the module:	SU/Ü - seminar lessons/exercise		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		

Examination performance:

prA - Practical work incl. acceptance interview of 30 min.

Further explanations:
None

Requirements according to SPO:

None

Recommended prerequisites:

Basics of object-oriented programming

Intended learning outcomes:

After successful participation in the module events

- know the most important sensors and actuators for autonomous mobile robots.
- students know which forms of knowledge representation are suitable for intelligent robots.
- students understand how to program with behavior patterns and master the common methods for map-based locomotion.
- students are able to use algorithms to record, merge and interpret sensor data and derive specifications for the actuators.
- students can apply the algorithms and concepts they have learned to practical applications in the fields of automobiles, service robotics, automation technology and care robotics.
- they can analyze practical tasks with regard to real-time conditions, safety requirements and the required behavior patterns.

- they are able to derive a strategic plan for the use of behavioral patterns from a problem.
- know real-time cooperation methods for teams of autonomous mobile robots.
- students can evaluate the different types of algorithms in terms of performance, real-time capability, robustness and flexibility.
- students can work on topics together in small groups and present the results of their work.

Contents:

- Sensors and actuators for intelligent robots
- Software architectures for autonomous mobile robots
- Knowledge-based behavior pattern control
- Environment modeling
- Route and action planning
- Cooperation of autonomous mobile systems
- Practical exercises in the laboratory

Literature:

- HERTZBERG, Joachim, Kai LINGEMANN and Andreas NÜCHTER, 2012. *Mobile Robots: An Introduction from a Computer Science Perspective, Springer*.
- VINJAMURI, Ramana, May 2023. *human-robot interaction: perspectives and applications* [online]. London, United Kingdom: IntechOpen PDF e-Book. ISBN 978-1-80356-412-8, 978-1-80356-411-1. Available at: 20.500.12854/113357.
- YANG, Huayong, LIU, Honghai, ZOU, Jun, YIN, Zhouping, LIU, Lianqing, YANG, Geng, OUYANG, Xiaoping, WANG, Zhiyong, 2023. *Intelligent robotics and applications: 16th international conference, ICIRA 2023, Hangzhou, China, July 5-7, 2023, proceedings, part II* [online]. Singapore: Springer PDF e-Book. ISBN 978-981-99-6486-4. Available at: https://doi.org/10.1007/978-981-99-6486-4.

Notes:

No comments

Social Implications of Artificial Intelligence			
Module abbreviation:	KIM_GesImplKI	**SPO no:**	6
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	1
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	summer term only
Module supervisor(s):	Uhl, Matthias		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total expenditure: 125 h		
Courses of the module:	Social Implications of Artificial Intelligence		
Teaching methods of the module:	SU/Ü - seminar lessons/exercise		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		
Examination performance:			
mdlP - oral examination 30 minutes Further explanations: None			
Requirements according to SPO:			
None			
Recommended prerequisites:			
Foundations of Ethics, Introduction to Economics			
Intended learning outcomes:			

The module will discuss the impact of the use of artificial intelligence on society. The course is divided into two major topic areas. In the first topic area, the ethical implications of AI are considered and reflected upon against the background of alternative normative theories. The possibilities of ethics through AI (machine ethics) as well as possible influences of AI on human behavior will be discussed. In the second topic area, the economic implications of AI are discussed. Here, in addition to a microeconomic analysis of individual markets, the macroeconomic influence of the technology on the national economy is in the foreground.

After completing the module, students will be able to

- distinguish the categories of ethics and characterize the features of ethical judgments.
- describe and criticize the most important normative theories.
- elaborate and reflect on specific issues of ethics of technology in general and ethics of AI in particular.
- discuss concrete applications of AI against the background of ethical theories.
- identify their own research questions on the ethics of AI and outline research designs to address them.
- assess the importance of AI for economics and replicate essential stylized data.

- analyze and exemplify the impact of AI from a microeconomic perspective.
- describe the influence of AI on the national economy and critically question forecasts in this area.
- elaborate own research questions of an economics of AI and outline research designs to address them.

Contents:

- Introduction to ethics
- The main normative theories for the social assessment of AI
- Conceptions of justice and algorithmic justice
- Behavioral ethics of technology, biases and heuristics, and their relevance to the ethics of AI
- The importance of empirical methods for the ethics of AI
- Ethics and paternalism of things
- The distinction between microeconomics and macroeconomics
- Microeconomic analysis of the impact of AI on the economy
- Consideration of the impact of AI on markets (labor, procurement, sales, financial)
- Macroeconomic analysis of the impact of AI on the national economy
- The connection between ethics and economics

Literature:

- AGHION, Philippe, Celine ANTONIN and Simon BUNEL, 2021. *The Power of Creative Destruction: Economic Upheaval and the Wealth of Nations*. 1st edition. ISBN 978-0674971165
- AGRAWAL, Ajay, Joshua GANS and Avi GOLDFARB, 2019. *The economics of artificial intelligence: an agenda*. Chicago and London: <<The>> University of Chicago Press. ISBN 978-0-226-61333-8
- COECKELBERGH, Mark, 2020 *AI ethics* [online]. Cambridge, Massachusetts; London, England: The MIT Press PDF e-Book. ISBN 978-0-262-35706-7. Available at: https://doi.org/10.7551/mitpress/12549.001.0001.
- LIAO, S. Matthew, 2020 *Ethics of artificial intelligence*. New York, NY: Oxford University Press. ISBN 978-0-19-090503-3, 978-0-19-090504-0

Notes:

None

AI in Safety-related Systems

Module abbreviation:	KIM_KISichRelSyst	**SPO no:**	7
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	1
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	summer semester only
Module supervisor(s):	Kugele, Stefan		
Credit points / SWS:	5 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 78 h Total expenditure: 125 h		
Courses of the module:	AI in Safety-related Systems		
Teaching methods of the module:	SU/Ü - seminar lessons/exercise		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		

Examination performance:

schrP90 - written examination, 90 minutes

Further explanations:
None

Requirements according to SPO:

None

Recommended prerequisites:

None

Intended learning outcomes:

After successfully completing the course, students will be able to

- understand and classify the requirements for a safety-critical/relevant system.
- discuss the risks and opportunities of using AI methods.
- be able to reproduce and apply procedures from relevant standards.
- determine the dangers and risks of a technical, software-intensive, AI-based system.
- Create safety cases using, for example, argumentation patterns.
- select and evaluate suitable architectures to achieve reliability goals.
- understand and apply formal verification techniques.

Contents:

- Cyber-physical and safety-critical/relevant systems
- Functional safety and key terms
- Guidelines and standards for safe systems (e.g. IEC 61508, ISO 26262, ISO/TR 4804:2020)

- Hazard analysis and risk assessment (G&R)
- Determination of Safety Integrity Level (e.g. SIL, ASIL)
- Safety analysis techniques
- Security cases and argumentation patterns (e.g. GSN)
- Security-specific architectures (design patterns: hardware patterns, software patterns)
- Analysis techniques for explainability and formal verification (e.g. robustness)

Literature:

- ISO, 2022. *22989: Information technology - Artificial intelligence - Artificial intelligence concepts and terminology*.
- ISO/IEC, 2022. *22989: Information technology - Artificial intelligence - Artificial intelligence concepts and terminology*.
- BÖRCSÖK, Josef, 2021 *Functional safety: Fundamentals of safety engineering systems*. 5th edition. Berlin; Offenbach: VDE Verlag GmbH. ISBN 978-3-8007-5357-4, 3-8007-5357-X
- GEBHARDT, Vera and others, 2013 *Functional safety according to ISO 26262: a practical guide to implementation*. 1st edition. Heidelberg: dpunkt.verlag. ISBN 978-3-86491-338-9

Notes:

No comments

Seminar

Module abbreviation:	KIM_Seminar	**SPO no:**	11
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	1
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	Summer semester only
Module supervisor(s):	Gröttrup, Sören		
Credit points / SWS:	3 ECTS / 2 SWS		
Workload:	Contact hours: 23 h Self-study: 52 h Total expenditure: 75 h		
Courses of the module:	Seminar		
Teaching forms of the module:	S - Seminar		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		

Examination performance:

SA - Seminar paper

Further explanations:
None

Requirements according to SPO:

None

Recommended prerequisites:

None

Intended learning outcomes:

After attending the module

- students have deepened their ability to independently acquire special technical knowledge (literature work, analysis, conclusions) and can present this in a comprehensible manner in an oral presentation using suitable media.
- students are able to critically follow a technical presentation and discuss the content with the speaker (strengthening communicative competence).
- students have strengthened their interdisciplinary and communicative skills.
- students can present the content of their presentation in the form of a short written paper.

Contents:

The subject of the seminar is always a topic from current research and development in the context of the study specializations offered.

The respective lecturer compiles a collection of publications from the specialist literature, which also forms the basic literature for the lectures.

In the course of the seminar, each participant has to design a whole double lesson (90 minutes) on a topic that is assigned to them by lot or choice at the beginning of the semester.

- In the preparation phase, each participant must conduct literature research on their topic and incorporate the results into a presentation.
- This presentation is given orally as part of a double lesson. The presentation should last approx. 60 minutes. The rest of the double lesson is reserved for discussion of the presentation.
- In addition, a written elaboration on the topic must be prepared. This paper should summarize the essential content of the presentation in prose and be between 5 and 10 pages in length (excluding pictures and lists).

The respective lecturer communicates detailed information on deadlines and his/her expectations regarding the design of the presentation and the written paper at the beginning of the semester.

Please note: Depending on the total number of participants, several seminar groups are usually offered, whereby the individual groups each deal with different seminar topics. Information on the specific topics of the seminar groups will be made available in the Moodle course room of the Artificial Intelligence course (https://moodle.thi.de/course/view.php?id=8638) before the start of the semester. The assignment of participants to the individual seminar groups takes place as part of the subject registration at the beginning of the semester. Further information will be announced via Moodle.

Literature:

Will be announced at the beginning

Notes:

Attendance is compulsory in this module.

Project

Module abbreviation:	KIM_Project	**SPO no:**	12
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	1
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	summer semester only
Module supervisor(s):	Gröttrup, Sören		
Credit points / SWS:	7 ECTS / 4 SWS		
Workload:	Contact hours: 47 h Self-study: 128 h Total expenditure: 175 h		
Courses of the module:	Project		
Teaching forms of the module:	Prj - Project		
Applicability for other degree programs:	The possibility of crediting must be clarified with the respective module supervisor or can be found in the faculty's crediting table.		

Examination performance:

PA - Project work

Further explanations:
None

Requirements according to SPO:

None

Recommended prerequisites:

AI and software components or entire applications are usually developed as part of the project. A solid grounding in the following areas is therefore required: programming, development with current machine learning frameworks (PyTorch, TensorFlow, ...), database systems, network technology, revision control (Git, Mercurial). Furthermore, knowledge in the field of agile project management (Scrum, Kanban) is required.

Intended learning outcomes:

After attending the module

- students have gained further practical experience in the application of project management methods.
- can handle tools that are used in the implementation of an IT project.
- students have developed their ability to deal with technical and non-technical problems that may arise during the implementation of a project lasting several weeks.
- students have developed their ability to analyze a complex technical task and successfully work on it in a team over the course of a semester.

- can report on the progress of the project in varying but always appropriate detail in oral and/or written form.
- the students have learned to critically scrutinize the technical and nontechnical (especially entrepreneurial) objectives of the project and to weigh them up in terms of the overall success of the project.

Contents:

Working in a team on a semester-long project task from the subject area of the Master's degree program.

In general, the projects are carried out in cooperation with external companies or the university's own research center. Alternatively, lecturers can also specify specific project topics to be worked on as part of their teaching or research activities.

The project management and organization are carried out by students. The lecturer/teaching assistant only acts as a coach and/or client.

Classic methods or agile methods such as Scrum or Kanban can be used as project management methods. It is up to the project team to decide which method to use.

At the beginning of the project, the lecturer/teaching supervisor clearly communicates his/her expectations regarding the dates, form and proof of individual performance to be provided by all students.

The project team agrees with the lecturer/lecturer on the forms of communication and documentation to be observed by all project participants (students, lecturer, client) for the duration of the project.

To be determined:

- Frequency and duration of planning meetings
- Type and conduct of meetings (joint or virtual/electronic)
- Regular meetings (possibly daily in the form of Scrum meetings, etc.)
- Type and scope of deliverables
- Type and scope of individual amounts by students
- Criteria for assessment/grading by the lecturer

Please note: Depending on the total number of participants, several project groups are usually offered, whereby the individual groups each deal with different project topics. Information on the specific topics of the project groups will be published before the start of the semester in the Moodle course room of the Artificial Intelligence (https://moodle.thi.de/course/view.php?id=8638) before the start of the semester. Participants will be assigned to the individual project groups as part of the subject registration at the beginning of the semester. Further information will be announced via Moodle.

Literature:

Will be announced at the beginning of the project.

Notes:

Project groups that are particularly suitable for dual study students are indicated in the topic description of the respective project groups.

Master Thesis

Module abbreviation:	KIM_MA	**SPO no:**	13
Assignment to the curriculum:	**Study program and direction**	**Type of module**	**Semester of study**
	Artificial Intelligence (SPO WS 22/23)	Compulsory subject	3
Module attributes:	**Language of instruction**	**Module duration**	**Offer frequency**
	English	1 semester	Winter and summer semester
Module supervisor(s):	Gröttrup, Sören		
Credit points / SWS:	30 ECTS / 0 SWS		
Workload:	Contact hours:		12 h
	Self-study:		738 h
	Total expenditure:		750 h
Courses of the module:	Master Thesis		
Teaching forms of the module:	MA - Master Thesis		
Applicability for other degree programs:	None		

Examination performance:

MA - Master's thesis

Further explanations:
None

Requirements according to SPO:

According to SPO §8 (2), the topic of the Master's thesis can be issued at the beginning of the second semester at the earliest. The topic of the Master's thesis can only be issued if at least 30 ECTS credits have been successfully completed (ibid.).

Recommended prerequisites:

None

Intended learning outcomes:

After the successful completion of the Master's thesis

- students can work on a problem independently and using scientific methods.
- can evaluate requirements, alternative solutions and possibly the development of individual solutions and present them in writing in a convincing and comprehensible manner.
- students have learned to complete a comprehensive task within a given time frame through effective time management.

Contents:

The Master's thesis is the academic conclusion of a Master's degree program. It should prove that a student is able to independently work on a complex task from the subject area of the degree program using appropriate scientific methods.

The student works on the task independently. This requires the will and ability to work on and successfully complete a task, as well as creativity in finding and / or designing solutions,

Writing a Master's thesis requires knowledge and skills in four areas:

- The relevant specialist knowledge required to work on the topic of the Master's thesis
- Techniques, methods and procedures of scientific work
- Project management (especially scheduling and controlling)
- Presentation techniques, if applicable

In general, the student chooses a topic for the Master's thesis independently. Topics are either offered internally by professors or academic staff at the university in notices (also online), or result from the student's cooperation with an external company.

In the case of an external topic, the student must obtain a lecturer from the university as the first examiner. For this purpose, it is advisable to outline the topic and the planned approach in a short paper. This exposé serves to provide the lecturer chosen as the first examiner with an overview of the topic of the thesis.

Literature:

- BALZERT, Helmut, Marion SCHRÖDER and Christian SCHÄFER, 2017. scientific work: Ethics, content & form of wiss. Work, tools, sources, project management, presentation. 2nd edition. Berlin; Dortmund: Springer Campus. ISBN 978-3-96149-006-6
- KORNMEIER, Martin, 2021. academic writing made easy: for Bachelor, Master and dissertation. 9th edition. Bern: UTB. ISBN 978-3-8252-5438-4, 3-8252-5438-0

Notes:

In addition to the literature on academic work, writing and presentation, which is independent of the topic mentioned above, topic-specific literature must be consulted for the Master's thesis, depending on the specific topic.

For dual students, the final thesis must be completed at the dual partner company in accordance with APO §30(5).