TECHNISCHE HOCHSCHULE DEGGENDORF

Module Guide
Artificial Intelligence

Faculty Computer Science
Examination regulations 15.04.2021
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AIN-B-1 Mathematics 1

Module code	AIN-B-1
Module coordination	Prof. Dr. Cezar Ionescu
Course number and name	AIN-B-1 Mathematics 1
Lecturer	Prof. Dr. Cezar Ionescu
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

Students understand and communicate the fundamental concepts of mathematics.

Specifically, students will have achieved the following outcomes upon completion of the module:

Subject competency

Students understand fundamental notions and methods of proof.

Methodological competency

Students model practical situations mathematically and select appropriate methods and techniques to answer the corresponding questions.

Personal competency

Students understand complex theoretical concepts and apply them to problems arising in practice.

Social competency

Students communicate clearly, argue and criticize logically and constructively, contribute to reasoned, team-oriented problem solving processes in the group.

Applicability in this and other Programs

This module is a fundamental building block of the AIN programme. It is a pre-requisite of Mathematics 2 and its contents are used in statistics, machine learning, deep learning, and many other modules in the programme.

Entrance Requirements

None

Learning Content

Discrete mathematics

- Logic
- Sets and functions
- Natural numbers and induction
- Recursive datatypes and structural induction

Real Analysis

- Functions of a real variable
- Sequences
- Series
- Continuity
- Differentiability
- Applications of differentiability
- The indefinite integral
- Definite integral and applications

Teaching Methods

- Interactive lectures
- Exercise sessions
- Practical experience with symbolic computation packages (e.g., sympy)

Recommended Literature

- Lincoln K. Durst, The Grammar of Mathematics , Addison-Wesley 1969
- Richard Earl, Towards Higher Mathematics , Cambridge University Press 2017
- McCluskey and McMaster, Undergraduate Analysis, Oxford University Press 2018

AIN-B-2 Programming 1

Module code	AIN-B-2
Module coordination	Prof. Dr. Markus Mayer
Course number and name	AIN-B-2 Programming 1
Lecturers	Prof. Dr. Markus Mayer NN NN PK WI/KI Michael Thurner
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Exercise Performance, written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

The students have basic knowledge of programming. The first part of of the lecture is on procedural programming (i.e. the students understand procedural programming and can write programs for simple task descriptions). The second part of the lecture is on object-oriented programming (i.e. the students understand the main concepts of object oriented programming and can write programs for simple task descriptions that are structured in an object-oriented way).

The following learning goals are reached after passing the module:

- Students understand basic concepts of software design.
- Students can perform a translation of simple task descriptions into procedural and object oriented program code
- Students know about coding style that allows for cooperative programming and understanding code of others and can apply the main concepts to their own code.
- Students know about the creative possibilities of programming and can apply this knowledge by developing their own ideas and translate them into code.

Applicability in this and other Programs

Basic introduction into Programming

Entrance Requirements

None

Learning Content

Contents of the lecture:

- Introduction into programming: "Hello world" or "Draw with code"
- Variables, Expressions, Statements
- Control structures (conditionals, loops)
- Data types (integer, floating point numbers, boolean, characters, strings)
- Arrays
- Functions
- Recursion
- Introduction to object orientation: Concepts
- Objects (classes and instances)
- Inheritance
- Static attributes and methods, attribute visibility

The contents to not imply the usage of a specific programming language. An example language were all the content can be shown is a combintation of Processing (a programming sketchbook based on Java, that allows for fast visualizations and simple games) and Java.

Teaching Methods

- Lecture with PowerPoint slides
- Live programming in the lecture

- Exercises to get practical experience that can be done in groups
- Exercises to get practical experience that are intended to work on them allone
- Etherpads to ask questions in iLearn
- Video recording of the lecture (if the lecture room supports that)

Remarks

None

Recommended Literature

- "Learning Processing" by Daniel Shiffman, "The coding train" Youtube lecture, https://www.youtube.com/playlist?list=PLzJbM9-DyOZyMZzVda3HaWviHqfPiYN7e
- "The nature of code" by Daniel Shiffman, available for pay-what-you-want download online, https://natureofcode.com (CC license)
- "Head First Java", Kathy Sierra and Bert Bates, Second Edition, 2005, O'Reilly

AIN-B-3 Foundations of Computer Science

Module code	AIN-B-3
Module coordination	Prof. Dr. Cezar Ionescu
Course number and name	AIN-B-3 Foundations of Computer Science
Lecturer	Prof. Dr. Cezar Ionescu
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Exercise Performance, written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

Students will aquire knowledge and understanding of the fundamental concepts and methods of computer science.

Specifically, students will have achieved the following learning outcomes upon completion of the module:

Subject competency

- Students know and understand the fundamental concepts and methods of computer science
- Students explain the fundamental concepts and apply them to practical examples

Methodological competency

- Students describe formally the syntax of programming languages and other kinds of symbolic expression
- Students implement regular expressions with minimal finite automata
- Students synthetize digital circuits from logical specifications

Personal competency

- Students recognize the similarities and differences between mathematical and engineering approaches
- Students explain the meaning of the digital transition and can evaluate its advantages and disadvantages.

Social competency

- Students evaluate competing approaches in exercise sessions, offer and answer constructive criticism.

Applicability in this and other Programs

This module is a pre-requisite for virtually all technical modules in the following semesters, including Computational Logic, Internet Technologies, Databases, Assistance Systems, AI Programming, etc.

Entrance Requirements

None

Learning Content

- Theoretical foundations of computer science
  - logic
  - computability
  - finite automata
  - formal languages
  - complexity
- Foundations of computer engineering
  - digital gates
  - digital circuits
  - computer architecture

Teaching Methods

- Interactive lectures

- Practical exercises using CAD tools, regular expression searches, BNF grammar builders, automata and formal languages simulators, etc.
- Mid-term tests the ability to use software tools for designing circuits and dealing with large data

Recommended Literature

- Susan H. Rodger und Thomas W. Finley: JFLAP: An Interactive Formal Languages and Automata Package , online bei http://jflap.org/
- Erich Hehner: Digital Circuit Design , Vorlesungsskript online bei http://www.cs.toronto.edu/~hehner/DCD/DCD.pdf
- J. Glenn Brookshear und Dennis Brylow: Computer Science--An Overview , 12th Ed, Pearson, 2015

AIN-B-4 Operating Systems and Networks

Module code	AIN-B-4
Module coordination	Prof. Dr. Andreas Wölfl
Course number and name	AIN-B-4 Operating Systems and Networks
Lecturer	Prof. Dr. Andreas Wölfl
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	
Language of Instruction	English

Module Objective

Acquisition of knowledge in the fundamentals of operating systems and data transmission in computer networks. Upon completion of the module, students will have achieved the following learning objectives:

Part Operating Systems:

- Students will gain knowledge of concepts and technologies necessary for building operating systems, as well as understanding of the modular structure and functionality of operating systems.
- Students will acquire knowledge and skills in the theoretical foundations, administration, and secure application of operating systems using Linux as an example.

- Students will learn the functioning and usage of the command-line interpreter and gain an overview of the most important shell commands.
- Students will acquire knowledge of methods and algorithms for file, memory, and process management.
- Students will classify and evaluate various operating modes, such as virtual machines or container-based virtualization, in the context of operating systems.

Part Operating Systems:

- Students will learn the basics structures and device arrangement in a computer network, including the physical and logical aspects.
- Students will evaluate network topologies based on graph-theoretical properties.
- Students will acquire knowledge of the structure and functioning of the Internet.
- Students will be able to calculate the key performance metrics like throughput or delay based on given network parameters.
- Students will recognize the significance of layered models and can assign tasks and functions to the layers of the ISO/OSI model.
- Students will gain knowledge about the major network protocols such as Ethernet, TCP, IP, DNS, and understand and explain the concepts of each protocol.
- Students will be able to program simple network applications using sockets.

Entrance Requirements

Learning Content

1 Introduction to Operating Systems
2 The Linux Operating System
3 Memory Management
4 IPC & Scheduling
5 Container-based Virtualization
6 Introduction to Networks
7 Network Structures
8 Data Transfer and Performance
9 Reference Models
10 Network Protocols
11 Network Programming

Teaching Methods

- Lectures

- Lab Practice

Recommended Literature

Andrew Tanenbaum, Nick Faemster, David Wetherall, *Computer Networks* , 6th ed., Pearson, 2021

Kurose, J., Ross, K., *Computernetze* , 6. ed, Pearson, 2014

Andrew Tanenbaum, Herbert Bos, Modern Operating Systems, Prentice Hall, 4th ed., 2014

Abraham Silberschatz, Peter Gavin, Greg Gagne, Operating System Concepts, John Wiley & Sons, 10th ed, 2018

Christine Bresnahan, Richard Blum, Mastering Linux System Administration, 1st. ed, Sybex, 2021

AIN-B-5 Introduction to Artificial Intelligence

Module code	AIN-B-5
Module coordination	Prof. Dr. Javier Valdes
Course number and name	AIN-B-5 Introduction to Artificial Intelligence
Lecturer	Prof. Dr. Javier Valdes
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 0 hours self-study: 90 hours virtual learning: 60 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	
Language of Instruction	English

Module Objective

Entrance Requirements

AIN-B-6 Key Competencies 1

Module code	AIN-B-6
Module coordination	Kathrin Auer
Course number and name	AIN-B-6 Media Skills and Self-Organization AIN-B-6 Business Administration
Lecturer	Kathrin Auer
Semester	1
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

The transition from school to university is a challenge for many students right at the beginning of their studies.

Moving away from predetermined timetables and curricula, towards independence, autonomy and responsibility. The module Key Competencies 1 is intended to respond to these challenges, particularly with a view to digitalization and the economic reference (internship in the 5th semester).

The learning outcomes of the module consequently consist of the two subjects "Business Administration" (Subject A) and "Media Competence and self-organization" (subject B).

Subject A

In the subject Business Administration, the students deal in particular with

general business administration, cost and performance accounting and

human resources management. Furthermore, contents are principles of procurement, logistics, marketing and business model creation and financial management. Although the students are taking a technical or computer science-oriented course of study, the knowledge acquired in the field of

business knowledge should make it easier for them to start their careers. Through the

broadening of the students' knowledge base it is intended thatsuboptimal decisions in companies can be avoided.

Professional competence

o The students get to know the operational functional areas in overview and selected concepts of corporate management/strategy development.

o The students know and understand the principles and methods of systematic decision making.

o The students know the purposes of cost and performance accounting (CCA) and the structure of cost and performance accounting.

o They are familiar with important instruments of cost and activity accounting, cost center and cost

center and cost unit accounting as well as short-term profit and loss accounting.

o They will be able to carry out cost center and order-related target/actual comparisons and evaluate them

o They will be able to apply direct costing in the form of contribution margin accounting.

o They will be able to carry out decision calculations on the basis of cost and performance accounting.

Subject B

The digital transformation of society is increasingly penetrating our professional and

everyday life and is characterized by a rapidly increasing abundance of information.

In order to deal with this amount of information and to be able to communicate, students need a high level of media competence. The contents of this subject are based on the media competence grid of the Standing Conference of the Ministers of Education and Cultural Affairs (2016) with its six pillars:

1. Searching, processing and storing
2. Communicating and cooperating
3. Producing and presenting
4. Protecting and acting safely
5. Problem solving and acting

6. Analyzing and reflecting

The competencies acquired in school are to be specifically expanded for the challenge of studying. The focus is no longer on searching for and presenting information, but rather its selection, evaluation and interpretation, analysis and synthesis. The subject introduces students both to the use of digital media in the context of studies, data protection and copyrights, and in independent organization of studies.

Subject competence

o The students are familiar with various digital media for organizing learning and are able to use them.

o The students will be able to select both analog and digital teaching and learning content for their studies.

o Students will be able to use digital media competently and in a targeted manner.

o The students are able to organize their studies in terms of time and content and to process the high amount of information in a targeted manner.

Subject A and B

Methodological competence

o The students are enabled to work in a transparency-, structure- and decision-oriented way.

o The students are made aware of the fact that the cost-performance calculation is to be conceived purpose-oriented.

o The students are enabled to work independently.

o Students acquire competencies in the use of digital media.

o Students will learn strategies for acquiring knowledge using blended learning methods.

Personal competence

o Through exercises, students learn to work independently and in a problem-, solution- and

and action-oriented world.

Social competence

o Students practice partner- and team work in the exercises.

o Students learn to work independently.

Applicability in this and other Programs

The module lays the foundations for the course of study in general and is linked in particular with the following advanced module:

AIN-B, KI-B and CY-B: Key Competencies 3.

AIN-B, KI-B and CY-B: Key Competencies 4

AIN-B, KI-B and CY-B: Internship module

AIN-B, KI-B and CY-B: Bachelor module

Course of studies: BA Artificial Intelligence (BA Künstliche Intelligenz and BA Cyber Security, both in in German language)

Entrance Requirements

No prerequisites.

Learning Content

Subject A

o The company at a glance

o Corporate management and corporate policy

o Vision, goals, strategies

o Constitutive corporate decisions

o Factors of production

o Operational functions

o Overview of the approaches of the decision theory

o Purposes of cost-performance accounting and cost allocation principles

o Systems of cost performance accounting

o Specific cost accounting contents in the areas of Artificial Intelligence and Cyber Security

o Cost-performance accounting on full cost basis

o Cost element accounting

o Cost center accounting

o Cost unit accounting

o Cost-performance accounting on partial cost basis (contribution margin accounting)

o The short-term profit and loss account

o Decision-oriented cost-performance accounting incl. the principle of relevant costs

- Principles of procurement
- Principles of logistics
- Principles of marketing
- Business model generation
- Principles of trade and service management
-

Subject B

o Information, data and knowledge

o Self-organization and study design
o Digital media in the student learning context
o Digital media in science and communication
o Data protection and netiquette
o Copyright and rights of use
o Media use and pillars of media competence

Teaching Methods

o Seminar-based teaching with group and partner work
o Project work
o Blended learning

Recommended Literature

Subject A

o Sangster, A. (2021): Frank Wood's Business accounting : an introduction to financial accounting, 15th edition, Pearson, Harlow (UK)
o McLaney, E. J. (2020): Accounting and finance: an introduction, 10th edition, Pearson, Harlow (UK)
o Elliott, B. (2019): Financial accounting and reporting, 19th edition, Pearson, Harlow (UK)
o Atrill, P. (2018): Management Accounting for decision makers, Pearson, Harlow (UK)
o Albrecht, W. Steve. (2012), Studyguide for Financial accounting, Content Technologies Inc., Milton Keynes

Subject B

o Heard, Stephen B. (2016): The Scientist?s Guide to Writing: How to Write More Easily and Effectively throughout Your Scientific Career, Princeton University Press, Princeton
Oldenbourg.
o Gapski, H., Oberle, M. & Staufer, W. (2017): Media literacy. Challenge
For politics, political education and media education. Bonn.
o Bühler, P. & Schlaich, P. (2016): Media literacy. Understanding digital media ?
create ? use.
o Mack, Chris A. (2018): How to write a good scientific paper, SPIE Press, Bellingham (WA)
o (Additionally internet documents and guides are used!).

AIN-B-7 Mathematics 2

Module code	AIN-B-7
Module coordination	Prof. Dr. Cezar Ionescu
Course number and name	AIN-B-7 Mathematics 2
Lecturers	Prof. Dr. Ruzin Aganoglu Prof. Dr. Cezar Ionescu
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Distance exam (BayFEV)
Weight	
Language of Instruction	English

Module Objective

Students understand and communicate the fundamental concepts of mathematics.

Specifically, students will have achieved the following outcomes upon completion of the module:

Subject competency

Students understand fundamental notions and methods of proof.

Methodological competency

Students model practical situations mathematically and select appropriate methods and techniques to answer the corresponding questions.

Personal competency

Students understand complex theoretical concepts and apply them to problems arising in practice.

Social competency

Students communicate clearly, argue and criticize logically and constructively, contribute to reasoned, team-oriented problem solving processes in the group.

Applicability in this and other Programs

This module is a fundamental building block of the AIN programme. Its contents are used in statistics, machine learning, deep learning, and many other modules in the programme.

Entrance Requirements

Mathematics 1

Learning Content

Complex numbers

- algebraic and trigonometric forms, geometric representation
- applications to geometry
- complex functions
- complex derivative, holomorphic functions

Linear systems and matrices

- operations on matrices
- invertible matrices
- linear systems, rank, Gaussian elimination
- linear programming

Vector spaces

- axiomatic definition and examples
- linear applications, matrix form of linear applications
- operations on linear applications

Differentiability in higher-dimensional spaces and applications

- total differential and partial derivatives
- gradient, hessian, jacobian
- Lagrange multipliers
- Kuhn-Tucker conditions for optimization

Iterative methods for optimization

- conjugate gradients
- steepest descent
- convergence analysis using eigenvectors and eigenvalues

Teaching Methods

- Interactive lectures
- Exercise sessions
- Practical experience with symbolic computation packages (e.g., sympy)

Recommended Literature

- Gilbert Strang, Introduction to Linear Algebra, 5th Ed, Wellesley-Cambridge Press , 2015
- Serge Lang, Undergraduate Analysis, 2nd Ed, Springer 1983

AIN-B-8 Programming 2

Module code	AIN-B-8
Module coordination	Prof. Dr. Markus Mayer
Course number and name	AIN-B-8 Programming 2
Lecturers	Prof. Dr. Andreas Berl Prof. Dr. Markus Mayer Prof. Dr. Florian Wahl
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Exercise Performance, written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

The knowlegde of programming is deepend and extendend to advanced concepts in "Programming II". The students have the ability to design, structure and implement complex tasks in either a procedural or object oriented programming behaviour.

The specific learning goals are:

- The students understand general programming concepts by inspecting their application in different programming languages.

- The students understand advanced object oriented programming and can apply them in their own implementations of tasks.
- The students understand the basic mechanisms of graphical user interfaces, file access, and event handling.
- The students can apply the knowledge of special language features and can decide for a programming language given tasks.
- The students are able to inspect, judge and modify code that was written by others and a variety of language extensions available in libraries.
- The students are able to write code that allows for software development in a team.

Applicability in this and other Programs

Advanced concepts of programming

Entrance Requirements

Programming I

Learning Content

1) Introduction to a new programming language and revision of the concepts of "Programming I" (e.g. if "Programming I" used the Java language as an example, Python can be employed for this part):
   - Datatypes, Control structures, Functions
   - Object oriented programming
2) Advanced programming concepts:
   - File handling
   - Exceptions and events
   - Graphical user interfaces
   - Threads
   - Iterables and iterators
3) Language specific in-depth knowledge, e.g. for Python:
   - Generators and list comprehensions
   - Decorators and OOP concepts in Python
4) Software design patterns (Decorator, Observer, Factory, Singleton, Adapter...)

Teaching Methods

- Lecture with PowerPoint slides
- Live programming in the lecture

- Exercises to get practical experience that can be done in groups
- Exercises to get practical experience that are intended to work on them allone
- Etherpads to ask questions in iLearn
- Video recording of the lecture (if the lecture room supports that)

Remarks

None

Recommended Literature

- "Design Patterns", Eric Freeman and Elisabeth Robson, O'Reilly, 2004
- "Dead Simple Python", Jason C. McDonald, United States, No Starch Press, 2023
- "Python Crash Course: A Hands-On, Project-Based Introduction to Programming", Eric Matthes, United States, No Starch Press, 2016.

AIN-B-9 Algorithms and Data Structures

Module code	AIN-B-9
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-9 Algorithms and Data Structures
Lecturer	Prof. Dr. Patrick Glauner
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Exercise Performance, written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

The aim of this class is to provide an introduction to one of the most important foundations of a computer science degree: algorithms and data structures. A data structure enables a programmer to structure data into conceptually manageable relationships. An algorithm is a finite sequence of well-defined, computer-implementable instructions to solve a class of problems or to perform a computation. Algorithms often operate on data structures. This course provides a journey through computer science. Students will acquire a solid foundation in how the most important algorithms and data structures work. They will also learn how to design efficient algorithms and data structures.

Specifically, students will have achieved the following learning outcomes upon completion of the module:

Subject competency
Students will understand the concepts of the most common algorithms and data structures. (2 - Understanding)

Methodological competency
Students will have the ability to develop high-quality programs using algorithms and data structures. (3 - Apply)

Personal competency
Students will be able to implement their own algorithms and data structures and defend them against competing approaches. (6 - Create)

Social competency
Programming exercises take place as part of the course. Students are thus able to understand, critique, and complement algorithms and data structures of other students. (5 - Assess)

Applicability in this and other Programs

Including, but not limited to, the following modules:

- Software Engineering
- Assistance Systems
- Natural Language Processing
- Machine Learning
- Computer Vision
- Deep Learning/Big Data

Entrance Requirements

- Content of the first semester, in particular Programming 1
- (Some) mathematics

Learning Content

- Introduction: algorithm definition, classification of algorithms
- Graphs: graph definitions, applications in computer science, shortest path, lowest cost, A*
- Complexity analysis: time complexity, O, Omega, Theta, o and O tilde notations, space complexity
- Lists: arrays, dynamic arrays/lists, amortization, fundamental operations, stacks, queues, linked lists
- Recursion: search, divide and conquer, recurrence relations, master theorem, backtracking, dynamic programming

- Sorting: bubble sort, selection sort, insertion sort, merge sort, quicksort, lower bounds
- Trees: binary trees, traversing, advanced types of trees, decision trees
- Maps and hash tables: key-value stores, hashing, collision handling
- Selected algorithms: fast matrix multiplication, string matching, prime numbers
- Quantum computing: qubits, quantum logic gates, quantum computers, quantum algorithms

Teaching Methods

- Lectures
- Discussion of research papers and recent news
- Coursework, including laboratory problems (mandatory problem - "Leistungsnachweis")

Recommended Literature

- M. Goodrich et al., " Data Structures and Algorithms in Python ", John Wiley & Sons, 2013.
- R. Sedgewick, " Algorithms ", Addison Wesley, fourth edition, 2011.
- M. Sipser, " Introduction to the Theory of Computation ", Cengage Learning, third edition, 2012.

AIN-B-10 Internet Technologies

Module code	AIN-B-10
Module coordination	Prof. Dr. Andreas Kassler
Course number and name	AIN-B-10 Internet Technologies
Lecturers	Prof. Dr. Goetz Winterfeldt Prof. Dr. Andreas Wölfl
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Practical Performance, written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

Subject competency

The students know technologies that they can use when designing interactive internet applications. They are able to use them efficiently in the implementation of projects.

The students can design websites. They know how to structure pages and know basic languages to design websites (CSS, HTML, Java Script). They can write small JavaScript programs. In the project, they can set up a node.js infrastructure, integrate a socket server and implement web components to deliver content to the browser.

Methodological competency

The students can use command line tools to connect to servers and exchange data. They can use server and client technologies to establish simple communication sessions between systems. They are able to use integrated development environments.

Social competency

Based on their knowledge, the students can carry out their own project. They can apply their knowledge of web technologies. They can evaluate the results of other groups and are evaluated themselves with their project. The students can use standard web programming tools (GIT, visual code, command line).

Personal competency

After completing the course, the students can carry out their own projects and develop Internet (web) applications. The course does not deal with databases and network technologies, as these topics are covered in other lectures.

Applicability in this and other Programs

This module is the basis for other computer science subjects and can be used in other programs, such as Ba. Media Technology, Ba. Interactive Systems or Ba. Cyber Security.

Entrance Requirements

- Programming 1
- Operating Systems and Networks

Learning Content

The module consists of two parts:

Part I: Internet technologies basics and part II: project work Internet technologies

Content part 1

(1) Tools and Installation

(2) Basics client - server, protocols for internet technologies

(3) Client-based Web Technologies

- HTML
- CSS
- JavaScript

(4) Server-side Technologies

(5) Proprietary Applications

- WebSockets
- data formats (JSON; XML)

- Session management

Contents part 2

Workshop: Setup Infrastructure - Cloud based Services

Project: Realization of a web application

Teaching Methods

Lecture, tutorials, practice session. In the second part of the course, a project is developed. The infrastructure will be set up during the lecture.

Remarks

The grading is divided into project and written examination. The project performance is evaluated according to a grading scheme. The written exam tests basic understanding.

Recommended Literature

(1) Turorials available from **https://www.w3schools.com/**

(2) Jonathan Wexler: Get Programming with Node.js, 978-1617294747

(3) Murach?s HTML and CSS: Training & Reference

(4) Adam Boduch et.al.: Learning jQuery 3 - Fifth Edition

(5) Responsive Web Design with HTML5 and CSS: Develop future-proof responsive websites using the latest HTML5 and CSS techniques, 3rd Edition, 2020, 978-1839211560

AIN-B-11 Computational Logic

Module code	AIN-B-11
Module coordination	Prof. Dr. Cezar Ionescu
Course number and name	AIN-B-11 Computational Logic
Lecturers	Prof. Dr. Cezar Ionescu Prof. Dr. Josef Schneeberger
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Distance exam (BayFEV)
Weight	5/120
Language of Instruction	English

Module Objective

Students aquire understanding and hands-on experience of various logical systems and their usage in artificial intelligence applications..

Specifically, students will have achieved the following outcomes upon completion of the module:

Subject competency

Students understand the significance of logic for intelligent problem-solving.

Methodological competency

Students select the most appropriate logical system for solving a concrete practical problem, and use it to implement software-based solutions.

Personal competency

Students understand complex theoretical concepts and apply them to problems arising in practice.

Social competency

Students communicate clearly, argue and criticize logically and constructively, contribute to reasoned, team-oriented problem solving processes in the group.

Applicability in this and other Programs

Logic is foundational for all computer science courses and programmes. This module is a pre-requisite for the more advanced artificial intelligence lectures that build upon it.

Entrance Requirements

Recommended:

- Mathematics 1
- Foundations of Computer Science

Learning Content

Formal Logic: Syntax and Semantics

- Introduction to logical languages
- Basic concepts of logic
- Propositional logic
- Predicate (first-order) logic
- Formal proofs
- Set theory
- Classical semantics for first-order logic
- Resolution for propositional and first-order logic
- Semantics of logic programming

Logical Programming

- Prolog
- Answer Set Programming

Teaching Methods

- Interactive lectures
- Practical exercises using automatic proof checkers and theorem provers

- Software implementation of application-oriented examples

Recommended Literature

- Barwise, J und Etchemendy, J: Language, Proof and Logic , CSLI 2003 (or newer)
- Lifschitz, V.: Answer Set Programming , Springer Verlag 2019
- Gebser, M., Kaminski, R., Kaufmann, B., Schaub, T.: Answer Set Solving in Practice , Morgan & Claypool Publishers, 2013

AIN-B-12 Key Competencies 2

Module code	AIN-B-12
Module coordination	Tanja Mertadana
Course number and name	AIN-B-12 Foreign Language (German or English)
Lecturer	Dozierende für AWP und Sprachen
Semester	2
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 60 hours Total: 120 hours
Type of Examination	See examination schedule AWP and languages, written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	German

Module Objective

The module Key Competencies 2 aims to provide students with specialised language skills. International students have to complete at least level A2 of German in the course of their studies. In addition, students can choose either courses offered by the faculty or German for Key Competencies 3, Key Competencies 4 and Key Competencies 5.

As part of this module, native German speakers shall instead take the course "Key Competency 2 - Subject-specific English" of the Cyber Security and Artificial Intelligence programmes.

The module covers the four basic language skills - listening, reading, speaking and writing. Students expand their subject-specific vocabulary and deepen their knowledge of the linguistic structures.

The learning outcomes of the respective German courses can be found in the corresponding course description on the homepage of the Language Centre: https://www.th-deg.de/en/students/language-electives#languages

Applicability in this and other Programs

Applicability of this module in other degree programmes is guaranteed.

Entrance Requirements

When registering for a course, the students' German language skills are assessed. Depending on the results, students are either allocated to a course corresponding to their language level or start with German A1/ part 1 + 2 if they are total beginners. After successful completion of a course, students can attend an advanced German course.

Learning Content

The course content can be found in the corresponding course description on the homepage of the Language Centre:
https://www.th-deg.de/en/students/language-electives#languages

Teaching Methods

The teaching methods focus on improving the four main language skills (listening, speaking, reading and writing). Examples of teaching methods used include various forms of group and individual work, mini-presentations, intensive reading and listening exercises, role-play and grammar games, loci method, dictation exercises, translations, peer feedback, work with learning stations, and various writing activities to consolidate the knowledge gained.

Students will be given weekly assignments for self-study.

Remarks

For course-specific details, please refer to the corresponding course description on the homepage of the Language Centre:
https://www.th-deg.de/en/students/language-electives#languages

All language courses require a compulsory attendance rate of 75% in order to be allowed to take the examination.

Recommended Literature

A list of the reading recommendations can be found in the corresponding course description on the homepage of the Language Centre:
https://www.th-deg.de/en/students/language-electives#languages

AIN-B-13 Databases

Module code	AIN-B-13
Module coordination	Prof. Dr. Udo Garmann
Course number and name	AIN-B-13 Databases
Lecturers	Prof. Dr. Wolfgang Dorner Prof. Dr. Udo Garmann
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	
Language of Instruction	English

Module Objective

The students learn basic concepts of database systems and how to use them.

After completing the module, the graduates have achieved the following teaching objectives:

- They can describe the development process for databases.
- You know the elements of an entity relationship model.
- An entity relationship model can be set up for a database.
- The graduate can detect anomalies and normalize tables.
- Databases can be managed with a database management system (DBMS).

- Database queries with SQL can be performed.
- The graduate knows the functions of a DBMS.

Method competence:

The student learns a simple version of the Backus-Naur form and can derive the syntax of SQL commands from it.

From a task, the student can develop a solution for a relational DB system using methods such as ER modeling.

For the DB system SQL statements to create an application can be develpoped.

Applicability in this and other Programs

Bachelor Applied Computer Science, Bachelor Interactive Systems, Artificial Intelligence, Bioinformatik, Cyber Security

Entrance Requirements

Programming 1 and 2

Learning Content

Introduction
- Introduction
- Why databases?
- examples

Terms, definitions and contexts
- Basic terms
- Relational Data Model
- databases
- DBMS
- Database Applications
- Keys in relational databases
- relational integrity

SQL
- Introduction
- SQL and the BNF
- DDL
- DML
- Tools (phpMyAdmin, sqlExplorer, Squirrel, etc.)

analysis and design
- Steps in database development
- Questioning techniques/information gathering

- use cases
- tools

ERM
- UML
- entities
- Relationships
- attributes
- multiplicity of relationships
- tools

normalization
- Introduction
- anomalies
- First normal form
- Functional dependencies and the 2NF
- Third NF

From design to implementation
- Introduction
- ER modeling
- Mapping the ER model to tables
- Normalize the tables
- Check business rules
- Check with users
- application development

Further aspects

Teaching Methods

Lectures with Exercises

Remarks

Students of Master AID may take this course as specific selection. Then they have to ask the professor about an additional work to achieve the credits.

Recommended Literature

- Thomas M. Connolly and Carolyn E. Begg. 2004:Database Solutions, A step-by-step guide to building databases, Pearson Education Limited, Harlow, Essex, England, 2nd Edition.
- Connolly, Thomas M., and Carolyn E. Begg. 2015. Database Systems: A Practical Approach to Design, Implementation, and Management. Global Edition (Englisch). 6th ed. Harlow, Essex, England: Pearson Education.

- Kifer, Michael, Arthur Bernstein, and Philip M. Lewis. 2006. Database Systems: An Application-Oriented Approach. 2nd ed. Boston, San Francisco, New York: Pearson Education.

AIN-B-14 Statistics

Module code	AIN-B-14
Module coordination	Prof. Dr. Markus Mayer
Course number and name	AIN-B-14 Statistics
Lecturers	Prof. Dr. Markus Mayer NN NN PK WI/KI
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

The main focus is the subject and methodological competency in the field of probability and statistics. By the nature of the subject, the gain of social compentences is not a major goal of the lecture, but is still supported by cooperative work on tasks. Personal competences are developed and refined by autonomous development of solutions to complex problems.

In detail, objectives of the lecture are:

- The students know solution templates to a variety of tasks in the field of probability computations and can select the appropriate ones for tasks that are described in natural language.
- The students know the methods from the field of statistic, specifically Bayesian statistics and can select the appropriate ones for tasks that are described in natural language.

Applicability in this and other Programs

Within the Bachelor AIN-B applicable for Machine Learning, Computer Vision

Entrance Requirements

Math 1 and 2

Learning Content

Probability:

- The difference between probability and statistics
- Counting and sets
- Probability experiments, Toy examples (coin, dice, urn)
- Conditional probability, independence and Bayes theorem
- Discrete and continuous random variables
- Expected value, standard deviation and variance
- Central limit theorem and the Law of large numbers
- Joint distributions and independence
- Covariance and correlation

Bayesian statistics:

- Maximum likelihood estimates
- Bayesian updating with discrete and continuous priors
- Probabilistic prediction
- Continuous data
- Conjugate priors
- How to choose priors
- Probability intervals

In terms of continuous random variables and conjugate priors, the focus is on the Gaussian distribution.

Teaching Methods

- Lecture with PowerPoint slides
- Script for self study

- Solution methods presented by the lecturer on the whiteboard and developed in group work
- Exercises in the lecture
- Exercises for self-study

Remarks

None

Recommended Literature

The course uses the script of the MIT Open CourseWare course " Introduction To Probability And Statistics ", https://ocw.mit.edu/courses/18-05-introduction-to-probability-and-statistics-spring-2014/. The script was developed by Dr. Jeremy Orloff and Jonathan Bloom and can be downloaded under a CC license.

AIN-B-15 Project Management

Module code	AIN-B-15
Module coordination	Prof. Dr. Markus Mayer
Course number and name	AIN-B-15 Project Management
Lecturers	Prof. Dr. Markus Mayer NN NN PK WI/KI
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Exercise Performance, written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

One focus is the subject and methodological competency in the field of project management. But contrary to the more technical subjects, social competences in the field of team development and personal competences in self assessment and resilience are also objectives.

In detail, objectives of the lecture are:

- The students know the inner workings of companies with development departments that are based on traditional or agile project based work.

- They understand the responsibilities and tasks of a traditional project manager and can exemplary perform a selection of them.
- They know the responsibilities and tasks of the positions in an example for agile project management (e.g. Scrum) and understand the differences to traditional project management.
- They know the techniques that lead to the formation of successful teams and the hindrances that prevent teams from being successful. They experienced team work in larger groups.
- They know techniques that help the developer/researcher/worker/ manager in a modern work environment to make valuable decisions and how to deal with situations of high pressure.

Applicability in this and other Programs

Applicable in Machine Learning, Computer Vision, Software Engineering, Natural Language Processing, Autonomous Robotics, Deep Learning etc. (in every course in AIN-B in the upcoming semesters). In addition, also applicable in the internship.

Entrance Requirements

None

Learning Content

- What is a project? What is project management?
- Project surroundings in a company
- Meetings
- Project Manager: Ethics, performance domains
- Traditional project management
    - Starting a project
    - Project planning
    - Carrying out the work
    - Project monitoring
    - Project closing
- Roles and responsibility, Team development, Conflict
- Leadership
- Agile project management:
    - Comparison to traditional methods
    - The agile manifesto
    - Scrum (Artifacts, Workflow, Roles)

During the lecture, exercises are done in groups of 4-5 and the groups have to organize themself with recommendations given by the lecturer how to encourage a team building

process. In addition, an agile experience day is scheduled to get insights into team building and task assignments under agile conditions.

Teaching Methods

- Lecture with PowerPoint slides
- Exercises for large group work
- Presentations of group work results by students
- Use of project management software
- Agile experience (Gamification elements)

Remarks

None

Recommended Literature

- "The Fast Forward MBA in Project Management: The Comprehensive, Easy-to-Read Handbook for Beginners and Pros" by Eric Verzuh, 5th edition, 2015, Whiley
- "Project management for Dummies" by Jonathan L. Portny and Stanley E. Portny, 6th edition, 2022
- "The Professional Scrum Team: Growing and Empowering Cross-functionality and Resiliency in a Complex World" by Peter Götz, Uwe M. Schirmer and Kurt Bittner, 2020, Scrum.org

AIN-B-16 Assistance Systems

Module code	AIN-B-16
Module coordination	Prof. Dr. Udo Garmann
Course number and name	AIN-B-16 Assistance Systems
Lecturer	Prof. Dr. Udo Garmann
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work
Weight	5/210
Language of Instruction	English

Module Objective

The students have the necessary skills to plan and create assistance systems. You know different definitions of the term "assistance system" as well as different forms of assistance systems such as language assistants or assistance systems for decision support.

Professional competence

The students know the history of language assistants.
The students know the basics of game and decision theory.
Students can plan a dialogue for a language assistant. They use aspects of "conversational design".
Students can develop a decision support system; this includes planning, algorithm development and implementation of a user interface.

Social skills

As part of the lectures, there are many exercises on project work. The students are thus able to understand and evaluate similar work by their fellow students. You are able to create documentation and software in a form that allows cooperation in a team. (5 - judge)

Methodical competence

The students have the ability to plan assistance systems and create them using Python or R. (3 - Apply)

Personal competence

The students can implement their own ideas and defend them against other approaches. (6 - Create)

Applicability in this and other Programs

Bachelor thesis

Entrance Requirements

Recommended:
Mathematics 2
Programming 2

Learning Content

Language processing basics
Conversational design
Development of a language assistant
Fundamentals of game and decision theory
Graphic representation of data and calculation results of machine learning methods
Development of a decision assistant including user interface

Teaching Methods

Instruction seminars
marketplace
discussions
presentations

Recommended Literature

May vary, because it is project-oriented lecture

- Moore R.J.. Conversational UX Design: Association for Computing Machinery. 2019
- Moore, R. J., Szymanski, M. H., Arar, R., & Ren, G. J. (Eds.) Studies in Conversational UX Design. Cham: Springer. 2018
- Pearl, C.. Designing voice user interfaces: Principles of conversational experiences. Beijing: O'Reilly. 2017
- Sievert Carson. Interactive Web-Based Data Visualization with R, plotly, and shiny. Chapman and Hall, 2020.

AIN-B-17 AI Programming

Module code	AIN-B-17
Module coordination	Prof. Dr. Cezar Ionescu
Course number and name	AIN-B-17 AI Programming
Lecturers	Prof. Dr. Cezar Ionescu NN NN PK WI/KI
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work
Weight	5/120
Language of Instruction	English

Module Objective

Students design, implement and test AI-based applications, both individually and in teams.
Specifically, students will have achieved the following outcomes upon completion of the module:

Subject competency

Students understand the fundamental AI methods and algorithms, and their implementation.

Methodological competency

Students develop programs using the appropriate AI tools (such as libraries, frameworks, programming languages).

Personal competency

Students understand the fundamentals of AI programming and apply them to problems arising in practice.

Social competency

Within the practical sessions that are an integral part of the course, students analyze the programs of their colleagues, communicate clearly, argue and criticize logically and constructively, contribute to reasoned, team-oriented problem solving processes in the group.

Applicability in this and other Programs

This module is foundational for further AI modules, such as Big Data/Deep Learning, New Topics in AI, etc.

Entrance Requirements

empfohlen:

Recommended:

AIN-1 Mathematics 1

AIN-2 Programming I

AIN-7 Mathematics 2

AIN-8 Programming II

AIN-9 Algorithms and Data Structures

AIN-11 Computational Logic

Learning Content

- Introduction to the programming language Python
- Neural networks and backpropagation
- Implementation of LLMs
- Symbolic computation
- Constraint-based programming
- SAT-Solvers
- SMT-Solvers

Teaching Methods

- Interactive lectures

- Exercise sessions
- Practical experience with AI tools (e.g., Z3)

Recommended Literature

- Thorsten Altenkirch und Isaac Triguero: *Conceptual Programming with Python* , Lulu 2019.
- Russell, S., Norvig, P. (2012), Künstliche Intelligenz, 3. Aufl., Pearson, München

AIN-B-18 Key Competencies 3

Module code	AIN-B-18
Module coordination	Prof. Dr. Javier Valdes
Course number and name	AIN-B-18 Technology Ethics and Sustainability AIN-B-18 Academic Writing
Lecturer	Prof. Dr. Javier Valdes
Semester	3
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work, written ex. 60 min.
Duration of Examination	60 min.
Weight	
Language of Instruction	English

Module Objective

Entrance Requirements

Remarks

For Key Competencies 3, students can choose either courses offered by the faculty or German.

AIN-B-19 Natural Language Processing

Module code	AIN-B-19
Module coordination	Prof. Dr. Udo Garmann
Course number and name	AIN-B-19 Natural Language Processing
Lecturers	Prof. Dr. Udo Garmann Prof. Dr. Patrick Glauner NN NN PK WI/KI
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Exercise Performance, written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

The goal of this module is to learn Natural Language Processing (NLP), which enables computers to process human language. We engage in NLP dozens of times a day, such as performing a Google search, correcting spelling on a smartphone, classifying email as spam, or recognizing handwriting. Modern NLP algorithms are heavily based on machine learning methods. The students acquire knowledge of NLP and can deepen this in the future, e.g. in projects or further studies.

The students know terms from linguistics such as syntax, semantics, etc. They understand the different structures of language. Understand and apply regular expressions (analysis and application) in Python. The students know the Natural Language Toolkit (NLTK). You can use the NLTK for different forms of language processing.

In detail, the students have achieved the following learning outcomes after completing the module:

Professional competence

Students understand the concepts of the most common approaches to language processing. (2 - understanding)

Methodical competence

Students have the ability to create high quality programs using speech understanding technologies. (3 - Apply)

Personal competence

The students can implement their own methods and defend them against competing approaches. (6 - Create)

Social skills

Programming exercises take place as part of the course. The students are thus able to understand, criticize and complement the programs of other students. (5 - judge)

Applicability in this and other Programs

AI-Project

Deep Learning/Big Data

Entrance Requirements

Recommended:

Mathematics 2

Programming 2

Algorithms and Data structures

Learning Content

Basics: stemming, stopwords, n-grams
Text classification: Naïve Bayes, spam filtering, speech recognition, logistic regression spelling correction
Search engines: ranking, vector space model, PageRank
Basics of formal languages (related to NLP problems)
Regular Expressions and Finite State Machines (Related to NLP Problems)

Context-free grammars (related to NLP problems)
Analysis of the speech signal
Outlook: Embeddings, current advances in NLP

Teaching Methods

Lectures
Discussion of scientific articles and breaking news
Exercises, including computer exercises (proof of achievement)

Recommended Literature

- S. Bird, E. Klein and E. Loper, " Natural Language Processing with Python Analyzing Text with the Natural Language Toolkit ", Online at [NLTK website](https://www.nltk.org/book), visited 20/03/31.
- C. Bishop, " Pattern Recognition and Machine Learning ", Springer, 2006.
- D. Jurafsky, " Speech and Language Processing, An Introduction to Natural Language Processing ", Computational Linguistics, and Speech Recognition, Third Edition draft, available online at [Jurafsky:Homepage] (https://web.stanford.edu/~jurafsky), visited 20/03/31.
- C. Manning, P. Raghavan and H. Sch#ütze, " Introduction to Information Retrieval ", Cambridge University Press, 2008.
- B. Pfister und T. Kaufmann, " Sprachverarbeitung, Grundlagen und Methoden der Sprachsynthese und Spracherkennung ", 2., aktualisierte und erweiterte Auflage, Springer-Verlag GmbH Deutschland 2017, ISBN 978-3-662-52837-2.
- S. Russel and P. Norvig, " Artificial Intelligence: A Modern Approach ", Prentice Hall, third edition, 2009.

AIN-B-20 Human Factors and Human-Machine Interaction

Module code	AIN-B-20
Module coordination	Prof. Dr. Christina Bauer
Course number and name	AIN-B-20 Human Factors and Human-Machine Interaction
Lecturers	Prof. Dr. Armin Eichinger Alexander Frummet NN NN PK WI/KI
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

Students understand and communicate the fundamental concepts of human-machine Interaction.

Specifically, students will have achieved the following outcomes upon completion of the module:

Subject competency

- Application of human factor principles to a specific domain
- Identification of various influences on the quality of work and interaction

Methodological competency

- Knowledge of various methodological approaches for investigating and evaluating human-machine interaction
- Systematic analysis and classification of situational influences
- Systematic analysis of error sources and types

Personal competency

- Realistic assessment of systemic influences on the work situation
- Improvement of team skills through knowledge of group mechanisms

Social competency

Students evaluate different user interface designs in exercise sessions. Thus, they able to understand and criticize different design decision and can justify their analyses.

Applicability in this and other Programs

All modules in which the consideration of human-computer-interaction mechanisms is a central subject.

Entrance Requirements

none

Learning Content

Introduction to the field of human-machine interaction

- Design of everyday objects
- Cognitive fundamentals
- Phenomena and mechanisms of attention

Information design

- Presentation of information
- Display design principles

Usability, UX

- Terms, models, processes
- Analysis methods
- Evaluation methods

Teaching Methods

- Interactive lectures

- Exercise sessions
- Group work

Recommended Literature

- Krug, S. (2013), Dont Make Me Think: A Common Sense Approach to Web Usability, 3rd revised edition, New Riders
- Norman, D. A. (2013), The design of everyday things, Basic Books, New York, NY
- Shneiderman, B., & Plaisant, C. (2010), Designing the user interface: strategies for effective human-computer interaction, Addison-Wesley, Boston

AIN-B-21 Machine Learning

Module code	AIN-B-21
Module coordination	Prof. Dr. Markus Mayer
Course number and name	AIN-B-21 Machine Learning
Lecturers	Prof. Dr. Robert Hable Prof. Dr. Markus Mayer NN NN PK WI/KI
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work
Weight	5/210
Language of Instruction	English

Module Objective

The main focus is the subject and methodological competency in the field of machine learning. By the nature of the subject, the gain of social compentences is not a major goal of the lecture, but is still supported by cooperative work on tasks and a project work done in teams. Personal competences are developed and refined by autonomous development of solutions to complex problems and the presentation of solutions within the class.

In detail, objectives of the lecture are:

- The students understand how to analyse a given dataset for its predictive quality and know how to motivate a classification or regression problem.

They can perform the computation of statistics and programming of visualizations and can select the appropriate methods for given datasets.
- The students can present a problem of supervised learning with remarks on predictive quality and the motivation.
- The students understand the basic methods of feature engineering and the construction of machine learning evaluations in a scientific, rigid way. They can apply this knowledge and implement the methods in code.
- The students understand the basic classification methods and their advantages and disadvantages. For a given problem, they can decide which to include in an evaluation and appropriatly parameterize library methods.
- The students know unsupervised learning and some of its usages. They understand an exemplary algorithm from this field and can do the implementation.

Applicability in this and other Programs

Applicable in AIN-B in Deep Learning, AI in Industry, AI in Gaming

Entrance Requirements

Math 1 and 2, Programming 1 and 2, Statistics

Learning Content

- Machine Learning Introduction
- Machine Learning Overview: Exemplary problems and solution classes
- Supervised learning experiment: Motivation
- Error and quality measures
- Bayes classifier, kNN classifier
- Training and test data selection
- Bayesian type classifiers
- Linear regression
- Feature engineering (Creation, Lifting, Selection)
- Outliers, Cross validation, Resampling
- Unsupervised Learning, K-Means clustering
- Gradient descent
- Support vector machines
- Decision tree classifiers

The main body of the lecture is supervised learning. Undsupervised learning is motivated and only exemplary shown.

Teaching Methods

- Lecture with PowerPoint slides
- Exercises in the lecture and for self study
- Presentation of the exercises by students with discussion
- Online course material for self study
- GIT repository for collectivelly setting up a code base

Remarks

None

Recommended Literature

- An Introduction to Statistical Learning, James, Witten, Hastie, Rob Tishirani, 2nd Edition, 2021, available online: https://www.statlearning.com
- MIT Open learning library: Introduction to machine learning. Online course, available at https://openlearninglibrary.mit.edu/courses/course-v1:MITx+6.036+1T2019/about

AIN-B-22 Computer Vision

Module code	AIN-B-22
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-22 Computer Vision
Lecturers	Prof. Dr. Patrick Glauner NN NN PK WI/KI
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work
Weight	5/210
Language of Instruction	English

Module Objective

The aim of this class is to discuss Computer Vision (CV), which allows computers to process visual inputs. We deal every day dozens of times with CV, such as facial recognition, real-time translating camera input or auto-tagging friends in photos. Modern CV algorithms are strongly based on machine learning methods, in particular deep neural networks. Students will acquire knowledge in CV and be able to elaborate it further in the future, for example in projects or further studies. Overall, CV is a cutting-edge eld, with many high-pay opportunities for graduates.

Applicability in this and other Programs

Including, but not limited to, the following modules:

- AI Project
- Deep Learning/Big Data

Entrance Requirements

- Programming, ideally in Python
- Algorithms and data structures
- (Some) mathematics

Learning Content

- Introduction: applications, computational models for vision, perception and prior knowledge, levels of vision, how humans see
- Pixels and filters: digital cameras, image representations, noise, filters, edge detection
- Regions of images: segmentation, perceptual grouping, Gestalt theory, segmentation approaches, image compression
- Feature detection: RANSAC, Hough transform, Harris corner detector
- Object recognition: challenges, template matching, histograms, machine learning
- Convolutional neural networks: neural networks, loss functions and optimization, backpropagation, convolutions and pooling, hyperparameters, AutoML, efficient training, selected architectures
- Image sequence processing: motion, tracking image sequences, Kalman filter, correspondence problem, optical flow
- Foundations of mobile robotics: robot motion, sensors, probabilistic robotics, particle filters, SLAM
- Outlook: 3D vision, generative adversarial networks, self-supervised learning

Teaching Methods

- Lectures
- Projects

Recommended Literature

- R. C. Gonzalez and R. Woods, " Digital Image Processing ", Pearson, 4th edition, 2018.
- I. Goodfellow, Y. Bengio and A. Courville, " Deep Learning ", MIT Press, 2016.

AIN-B-23 Software Engineering

Module code	AIN-B-23
Module coordination	Prof. Dr. Thomas Buchmann
Course number and name	AIN-B-23 Software Engineering
Lecturers	Prof. Dr. Thomas Buchmann NN NN PK WI/KI Prof. Dr. Andreas Wölfl
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work
Weight	5/120
Language of Instruction	English

Module Objective

Students will aquire knowledge and understanding of the fundamental concepts and methods of software engineering.

Specifically, students will have achieved the following learning outcomes upon completion of the module:

Subject competency

- Students know and understand the fundamental concepts and methods of software engineering
- Students are able to apply fundamentals of project management

- Students are able to specify requirements
- Students are able to perform reviews

Methodological competency

- Students are able to perform an object-oriented design using UML in a systematic manner
- Students are able to define and conduct different test strategies based on requirements

Personal competency

- Students work goal-oriented and acquire a high degree of determination
- Using agile methods fosters self-motivation
- Working in a task-oriented way helps to empower a problem-solving way of thinking

Social competency

- Students are able to organize themselves in small groups to conduct a software project
- Students actively participate in team meetings fostering their ability to work in teams

Entrance Requirements

- Knowledge of the following modules:
  - Foundations of Computer Science
  - Programming 1
  - Programming 2
  - Internet Technologies

Learning Content

1 Motivation and Definition
2 Software Engineering Lifecycle
3 Software Process Models
4 Methodology
  - Requirements Engineering
  - Software Design
  - Architecture and detailed design
  - Object-oriented analysis and design (OOA, OOD)
  - UML Introduction
  - UML Workshop (Diagrams and their application)
  - Example
  - Transition from Analysis to design
5 Implementation

- Coding conventions
- Static code analysis
- Code metrics

6 Software Test
- Static test
- Dynamic test
- Testing process
- Testing methods and strategies

7 Software Quality Assurance
- Definition
- Reviews

Teaching Methods

- Interactive lectures
- Practical exercises using CASE tools
- Conducting a small software project in a team

Recommended Literature

- H. Balzert, Lehrbuch der Software-Technik, Spektrum Akademischer Verlag
- I. Sommerville, Software Engineering, Addison Wesley Verlag
- B. Kahlbrandt, Software-Engineering mit der UML, Springer Verlag
- C Rupp et. al., UML 2 - Glasklar, Hanser Verlag
- A. Spillner, T. Linz, Basiswissen Softwaretest, dpunkt Verlag
- B. Beizer, Black - Box Testing: Techniques for Functional Testing of Software and Systems, Wiley Verlag
- P. Liggesmeyer, Software - Qualität: Testen, Analysieren und Verifizieren von Software, Spektrum Verlag
- H. Sneed, M. Winter, Testen objektorientierter Software, Hanser Verlag

AIN-B-24 Key Competencies 4

Module code	AIN-B-24
Module coordination	Dr. David Bomhard
Course number and name	AIN-B-24 Compliance, Data Protection and IT Law
Lecturers	Dr. David Bomhard Michael Donnert Anke Hofmeyer NN NN PK AI/IAS/CS NN NN PK WI/KI Prof. Dr. Josef Scherer
Semester	4
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Weight	5/210
Language of Instruction	English

Module Objective

In this lecture, students gain an in-depth overview of the most important legal framework conditions in the area of AI, data and IT law. Current legal developments are presented in depth, in particular the planned EU AI Act. Through interactive discussions, students

learn the basics for drafting and negotiating IT contracts and ensuring compliance within a company.

Entrance Requirements

None

Learning Content

- Data Law (GDPR, draft Data Act, data license agreements)
- AI Law (Liability, IP regulations, draft AI Act)
- IT Contracts (legal basics, drafting, negotiation)
- Current legal developments in Compliance and EU legislation

Teaching Methods

Interactive lecture, strong involvement of students through questions and selective group work

Remarks

For Key Competencies 4, students can choose either courses offered by the faculty or German.

Recommended Literature

The lecturer will discuss selected legal texts in the original version.

AIN-B-25 Internship (Module)

Module code	AIN-B-25
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-25 Internship AIN-B-25 Internship-Accompanying Course 1 AIN-B-25 Internship-Accompanying Course 2
Lecturers	Gökçe Aydos Prof. Dr. Patrick Glauner NN NN PK WI/KI
Semester	5
Duration of the module	1 semester
Module frequency	annually
Course type	PLV, required course
Level	Undergraduate
Semester periods per week (SWS)	4
ECTS	30
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Exercise Performance,
Weight	5/210
Language of Instruction	English

Module Objective

The practical semester is an integral part of the course of study. The aim is to gain practical experience in an industrial environment.

Applicability in this and other Programs

- Courses in later semesters

- Bachelor thesis

Entrance Requirements

Entry into the practical semester requires that at least 70 ECTS points have been earned.

Learning Content

The practical semester is an integral part of the course of study. It is supervised by the university and accompanied by courses according to the curriculum. The internships are primarily to be carried out in companies in Germany and abroad. The aim is to gain practical experience in an industrial environment. The students have the opportunity to get to know different companies during their studies.

Teaching Methods

- Internship
- Two accompanying one-week block courses

Recommended Literature

None

AIN-B-26 Current Topics in AI

Module code	AIN-B-26
Module coordination	Sabine Vogl
Course number and name	AIN-B-26 Current Topics in AI
Lecturers	NN NN PK WI/KI Prof. Dr. Florian Wahl
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	oral examination, Exercise Performance
Language of Instruction	English

Module Objective

AIN-B-27 Autonomous Robotics

Module code	AIN-B-27
Module coordination	Sabine Vogl
Course number and name	AIN-B-27 Autonomous Robotics
Lecturers	NN NN PK WI/KI Prof. Dr. Simon Zabler
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	written ex. 90 min.
Duration of Examination	90 min.
Language of Instruction	English

Module Objective

AIN-B-28 AI Project

Module code	AIN-B-28
Module coordination	Sabine Vogl
Course number and name	AIN-B-28 AI Project
Lecturers	Prof. Dr. Patrick Glauner NN NN PK WI/KI Prof. Dr. Florian Wahl
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work
Language of Instruction	English

Module Objective

AIN-B-29 Deep Learning/Big Data

Module code	AIN-B-29
Module coordination	Sabine Vogl
Course number and name	AIN-B-29 Deep Learning/Big Data
Lecturers	Prof. Dr. Patrick Glauner NN NN PK WI/KI Prof. Dr. Florian Wahl
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	project work
Language of Instruction	English

Module Objective

AIN-B-30 Compulsory Elective 1 (FWP)

Module code	AIN-B-30
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-30 Compulsory Elective 1 (FWP)
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	compulsory course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 0 hours Total: 0 hours
Type of Examination	Examination form of the chosen module
Language of Instruction	English

Module Objective

AIN-B-31 Key Competencies 5

Module code	AIN-B-31
Module coordination	Sabine Vogl
Course number and name	AIN-B-31 Team Building and International Communication AIN-B-31 Entrepreneurship
Lecturers	Prof. Dr. Thomas Geiß NN NN PK WI/KI Prof. Dr. Johann Nagengast
Semester	6
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Level	
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Weight	
Language of Instruction	English

Module Objective

Entrance Requirements

Remarks

For Key Competencies 5, students can choose either courses offered by the faculty or German.

AIN-B-32 Compulsory Elective 2 (FWP)

Module code	AIN-B-32
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-32 Compulsory Elective 2 (FWP)
Lecturers	Dozierende der ausgewählten Wahlpflichtfächer Lecturer of the chosen Electives NN NN PK WI/KI
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	compulsory course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 0 hours Total: 0 hours
Type of Examination	Examination form of the chosen module
Language of Instruction	English

Module Objective

AIN-B-33 Compulsory Elective 3: AI Applications 1 (FWP)

Module code	AIN-B-33
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-33 Compulsory Elective 3: AI Applications 1 (FWP)
Lecturers	Prof. Dr. Patrick Glauner Dozierende der ausgewählten Wahlpflichtfächer Lecturer of the chosen Electives
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	compulsory course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 90 hours self-study: 60 hours Total: 150 hours
Type of Examination	Examination form of the chosen module
Language of Instruction	English

Module Objective

AIN-B-34 Compulsory Elective 4: AI Applications 2 (FWP)

Module code	AIN-B-34
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-34 Compulsory Elective 4: AI Applications 2 (FWP)
Lecturers	Prof. Dr. Patrick Glauner Dozierende der ausgewählten Wahlpflichtfächer Lecturer of the chosen Electives
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	compulsory course
Semester periods per week (SWS)	4
ECTS	5
Workload	Time of attendance: 60 hours self-study: 90 hours Total: 150 hours
Type of Examination	Examination form of the chosen module
Language of Instruction	English

Module Objective

AIN-B-35 Bachelor Seminar

Module code	AIN-B-35
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-35 Bachelor Seminar
Lecturer	NN NN PK WI/KI
Semester	7
Duration of the module	1 semester
Module frequency	annually
Course type	required course
Semester periods per week (SWS)	2
ECTS	3
Workload	Time of attendance: 30 hours self-study: 45 hours Total: 75 hours
Type of Examination	colloquium
Language of Instruction	English

Module Objective

AIN-B-36 Bachelor Thesis

Module code	AIN-B-36
Module coordination	Prof. Dr. Patrick Glauner
Course number and name	AIN-B-36 Bachelor Thesis
Semester	7
Duration of the module	1 semester
Module frequency	as required
Course type	required course
Semester periods per week (SWS)	12
ECTS	12
Workload	Time of attendance: 0 hours Total: 0 hours
Language of Instruction	English

Module Objective