Aalen University of Applied Sciences

Module handbook

SoSe 26

Master Machine Learning and Data Analytics (MLD)
SPO-31

March 6, 2026

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Advanced Programming with MOSTflexiPL

28922

Module Number	28922
Module Manager	Prof. Dr. Heinlein
E-Mail	christian.heinlein@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	
Modul Type	Elective
Language	English
Use in other SG	
Module Duration	1 Semester

Participation Requirements:

Module Objectives

Course Content:

- Benefits of syntactically extensible programming languages
- Basic principles of MOSTflexiPL
- Predefined types and operators
- Simple user-defined operators
- Definition of precedence and associativity, definition of complex precedence hierarchies
- Definition of operator visibilities
- Procedural and functional style of programming
- Operators with optional, alternative, and repeatable syntax parts
- Generic types and operators
- Static operators and complex user-defined data structures
- Complex user-defined control flow operators
- Operators as parameters and result of other operators
- Implicit parameters

- Virtual operators
- Extension and adaptation of the syntax to define new syntax

Professional Competence:

- Participants can explain the drawbacks of prevalent programming languages and the benefits of extensible languages and substantiate them with convincing examples.
- They can write advanced programs in the extensible language MOSTflexiPL using complex language constructs.
- They can reasonably design and implement extensive operator libraries and deeply explain their design decisions.

Interdisciplinary Competence: Paricipants can develop programs and libraries in teams.

Literature: Will be announced during the lectures.

Type:

- Lecture
- Excercise
- Project work

Module Examination

Requirements for Admission to the Module Exam:

Final grade: PLP graded 100 %

Auxiliary means:

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
28922: Advanced Programming with MOSTflexiPL *Prof. Dr. Christian Heinlein*				
5	4		V, Ü, P	PLP

Comments

This course is not offered periodically. The maximum number of participants is 10.

Artificial Intelligence

56001

Module Number	56001
Module Manager	Prof. Dr. Dominik Müller
E-Mail	dominik.mueller@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	Summer term
Modul Type	Mandatory
Language	English
Use in other SG	MIN
Module Duration	1 Semester

Participation Requirements: Formal: —
Content related: Mathematical basics, algorithms and data structures

Module Objectives

Course Content:

- Fundamentals of artificial intelligence and modern AI paradigms
- Model adaptation and alignment (e.g., fine-tuning, parameter-efficient methods)
- Data-centric AI: datasets, preprocessing, data quality, and governance
- Evaluation and validation of AI systems (metrics, benchmarking, reliability)
- Current developments in AI (selected topics)

Professional Competence: The students are able to apply fundamental principles and methods of artificial intelligence. They are able to analyse assumptions, limitations, and risks of AI systems and to develop and evaluate suitable approaches for typical AI tasks and applications.

Interdisciplinary Competence: The students train their independence and ability to work in a team through exercises that can be done individually and in groups. On selecting AI-Solutions, they are able to take into account not only technical aspects, but also ethical consequences.

Literature:

1. Stewart Russel, Peter Norvig: Artificial Intelligence. A Modern Approach, Pearson.

Type:

- Lecture
- Excercise

Module Examination

Requirements for Admission to the Module Exam: Formal: —
Content related: Mathematical basics, algorithms and data structures

Final grade: PLK 120, graded. Grade of the written examination

Auxiliary means: Any written or printed material

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56101: Artificial Intelligence *Prof. Dr. Dominik Müller*				
5	4	1/2	VÜ	PLK 120, graded

Comments

Exercises are dicussed reguarly during lectures

Machine Learning and Deep Learning

56002

Module Number	56002
Module Manager	Prof. Dr. Tim Dahmen
E-Mail	tim.dahmen@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	Summer term
Modul Type	Mandatory
Language	English
Use in other SG	Can be selected from other master's programs. Limited number of participants.
Module Duration	1 Semester

Participation Requirements: none

Module Objectives

Course Content:

- Basics: Machine Learning (ML), Exploratory Data Analysis, Data Reparation, Validation, Generalization
- Artificial Neutral Networks
- Deep Learning
- Introduction to Artificial Neural Networks
- Basic Building Blocks
- Learning in Neural Networks
- Examples and Architectures
- Deep Learning
- The General Idea of Deep Learning
- Convolutional Neural Networks
- Architectures
- Transfer Learning
- Autoencoders

Professional Competence: Students are able to use machine learning methods to develop applications for classification and regression models and use them within their area of expertise.

Students can apply various machine learning methods. They are able to select and apply the correct methods for a specific problem. They are able to critically examine and evaluate the results of the application. They are able to implement examples and tasks using the scikitlearn, tensorflow, keras or pytorch libraries.

Interdisciplinary Competence: Students can work on smaller problems both independently and in teams. They present their work in presentations and can justify their choice of methods.

Literature:

1. Rebala, G. et al.: An Introduction to Machine Learning. Springer
2. Duda et al.: Pattern Classification. Wiley-Interscience.
3. Abu-Mostafa: Learning from Data - A short course. Bilingual Books.
4. Joshi, Ameet V, Machine Learning and Artificial Intelligence. Springer
5. Singh, Pramood et al.: Learn TensorFlow2.0 – Implement Machine Learning and Deep Learning. Springer

Type:

- Excercise
- Lecture

Module Examination

Requirements for Admission to the Module Exam: none

Final grade: PLK, 100%

Auxiliary means: none

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56102: Machine Learning and Deep Learning *Prof. Dr. Tim Dahmen*				
5	4	1/2	VÜ	PLK 120

Comments

Natural Language Processing

56003

Module Number	56003
Module Manager	Prof. Dr. Winfried Bantel
E-Mail	winfried.bantel@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	Summer term
Modul Type	Mandatory
Language	English
Use in other SG	Master Informatik as elective module
Module Duration	1 Semester

Participation Requirements: -

Module Objectives

Course Content:

- Natural an formal languages
- Text Classification
- Named Entity Recognition
- Coocurance Ananlysis
- Vectorization of Text
- Information Retrieval
- Textmining
- Large Language Models
- Prompt Engineering
- Fine Tuning of Large Language Models
- Classic Language Processing
- Large Language Models

Professional Competence: Students comprehend processing of natural language. They synthesize these processes to new problems and understand how to deduct new solutions.

Interdisciplinary Competence:

Literature:

- Natural Language Processing Recipes, Akshay Kulkarni and Adarsha Shivananda
- Deep Natural Language Processing, Hirschle (German)
- Mastering spaCy, Duygu Altınok
- Natural Language Processing mit PyTorch, Delip Rao und Brian McMahan (German and English available)
- Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper (German an English available)
- Getting Structured Data from the Internet, Jay M. Patel
- Praxiseinstieg Large Language Models, Sinan Ozdemir (German and English available)

Type:

- Lecture
- Seminar
- Project work
- Excercise

Module Examination

Requirements for Admission to the Module Exam: -

Final grade: PLK (50%) und PLP / PLR (50%)

Auxiliary means: All

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56103: Natural Language Processing *Prof. Dr. Winfried Bantel*				
5	4	1/2	VÜ	PLP

Comments

Data Analytics

56004

Module Number	56004
Module Manager	Prof. Dr. Tim Dahmen
E-Mail	tim.dahmen@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	Winter term
Modul Type	Mandatory
Language	English
Use in other SG	
Module Duration	1 Semester

Participation Requirements: Formal: —
Content related: —

Module Objectives

Course Content:

- Descriptive statistics
- Data preparation, data visualization
- Hypothesis testing
- Discriminant analysis
- Time series analysis
- Cluster analysis
- Interpolation techniques

Professional Competence: Students can apply various data analysis and visualisation methods. They are able to select the correct methods for a specific problem and apply them. They are able to critically examine the results of the application and evaluate them. They are able to implement examples and tasks using the Python library pandas and matplotlib.

Interdisciplinary Competence: Students can work on smaller problems both independently and in teams. They present their work in presentations and must justify their choice of methods.

Literature:

1. Deokar et al.: Analytics and Data Science. Springer (2018)
2. Hedderich, Sachs: Angewandte Statistik. Springer (2018)
3. Grus: Einführung in Data Science. O'Reilly (2016)

Type:

- Lecture
- Excercise

Module Examination

Requirements for Admission to the Module Exam: Formal: —
Content related: —

Final grade: PLK, 100%

Auxiliary means: Keine Hilfsmittel.

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56201: Data Analytics *Prof. Dr. Tim Dahmen*				
5	4	1/2	VÜ	PLK 120

Comments

Predictive Analytics

56005

Module Number	56005
Module Manager	Prof. Dr. Martin Heckmann
E-Mail	martin.heckmann@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	Winter term
Modul Type	Mandatory
Language	English
Use in other SG	
Module Duration	1 Semester

Participation Requirements: none

Module Objectives

Course Content:

- Basic concepts: Machine learning, exploratory data analysis, preparation of data sets, validation models
- Supervised learning, unsupervised learning, reinforcement learning
- Regression, classification
- Functions of several variables
- Partial derivatives
- Gradient
- Gradient descent
- Optimization with constraints
- Regularization
- Ridge regression
- Lasso
- Maximum Likelihood Estimation
- Logistic regression, decision trees, . . .
- Ensemble methods

- Bagging
- Random Forest
- Boosting
- Evaluation of classifiers
- Error rate
- Confusion matrix
- Precision, Recall, Sensitivity, Specificity
- Receiver Operating Curve (ROC)

Professional Competence: General:
Students are able to develop and apply data-driven prediction models.
Students can effectively plan statistical experiments, carry out data collection and process data. They are able to select and apply the correct methods for a specific problem. They are able to critically examine and evaluate the results of the analysis.

Interdisciplinary Competence: Smaller problems are dealt with both independently and in teams.

Literature:

1. James, Witten, Hastie, Tibshirani: An Introduction to Statistical Learning with Applications in Python, 1st Edition. Springer (2023)
2. Géron: Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems, 3rd Edition. O'Reilly Media (2022).
3. Bishop: Pattern Recognition and Machine Learning. Springer (2006)
4. Ng: Machine Learning Yearning. deeplearning.ai (2018).
5. Murphy: Machine Learning: A Probabilistic Perspective. MIT Press (2012)

Type:

- Lecture
- Excercise

Module Examination

Requirements for Admission to the Module Exam: none

Final grade: PLK 90, 100%

Auxiliary means: Lecture notes, lecture slides, scientific calculator (non graphing, not programmable), printouts, books

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56202: Predictive Analytics *Prof. Dr. Martin Heckmann*				
5	4	1/2	VÜ	PLK 90

Comments

Big Data & Data Mining

56006

Module Number	56006
Module Manager	Prof. Dr. Gregor Grambow
E-Mail	gregor.grambow@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	Winter term
Modul Type	Mandatory
Language	English
Use in other SG	
Module Duration	1 Semester

Participation Requirements: Formal: —
Content related: Relational databases, SQL, programming skills (Java, Python), working with VMs/Docker

Module Objectives

Course Content:

- Definition and properties of Big Data
- Definition of Data Mining
- Distributed data processing with MapReduce
- Apache Hadoop
- Hadoop eco system: Hive, Pig, HDFS, ...
- Apache Spark, Spark ML, Spark Streaming, Spark SQL, Spark GraphX
- Consistency in distributed environments (ACID, BASE, CAP Theorem)
- Replication and Sharding
- Graph Databases
- Document Databases
- Key-Value Stores
- Wide Column Stores
- Specific characteristics of the various database technologies/paradigms: data definition, query languages

- Stream Processing and Complex Event Processing
- Data Warehousing

Professional Competence: Students will be able to classify the data structures and algorithms on which the distributed processing and analysis of large amounts of data is based. They understand the problems and specifics of distributed data processing. They will be able to classify and evaluate various modern database paradigms and technologies and will be able to select and apply the correct database paradigms and technologies for a specific problem. They can apply approaches for distributed data processing and analysis. They are able to critically examine and evaluate the results of the application.

Interdisciplinary Competence: Students are able to work on smaller problems both independently and in teams. Students are aware of their personal learning progress as part of continuous exercises and can deal with constructive and critical feedback based on this; they are able to work together in teams during practical exercises, communicate with each other in a solution-oriented manner and support each other. They can research information, evaluate the quality of the sources found and use suitable material

Literature:

1. White: Hadoop: The Definitive Guide. O'Reilly Media, Inc.
2. Robinson, Webber, Eifrem: Graph Databases: New Opportunities for Connected Data.
3. Wiese: Advanced Data Management: For SQL, NoSQL, Cloud and Distributed.
4. Perrin: Spark in Action, Second Edition, Manning Publications.
5. Hueske, Kalavri: Stream Processing with Apache Flink
6. Carpenter, Hewitt: Cassandra. The definitive Guide, O'Reilly.
7. Carlson: Redis in Action, Manning Publications

Type:

- Lecture
- Excercise
- Laboratory

Module Examination

Requirements for Admission to the Module Exam: Successful participation in the laboratory exercises

Final grade: PLK 90, 100%

Auxiliary means: All printed or handwritten documents.

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56203: Big Data & Data Mining *Prof. Dr. Gregor Grambow*				
5	4	1/2	VÜL	PLK 90

Comments

Seminar

56007

Module Number	56007
Module Manager	program coordinator
E-Mail	roy.oberhauser@hs-aalen.de
Credits	5
Workload Class	30
Workload Self-Study	120
Offered	Winter term, Summer term
Modul Type	Mandatory
Language	English
Use in other SG	
Module Duration	1 Semester

Participation Requirements: Formal: —
Content related: —

Module Objectives

Course Content: Independent research and identification of relevant content relating to a previously selected topic.

Scientific approach to the acquisition and processing of content.

Independent writing of a summarizing paper on the chosen topic.

Presentation of the compiled information and findings in a seminar presentation.

Professional Competence: Depending on their choice of topic, students are able to analyze and prepare a scientific topic in a structured manner and present their findings appropriately.

Interdisciplinary Competence: Students can research information, evaluate the quality of the sources found and use suitable material. They are able to present their own solutions concisely, quickly grasp other people's solutions and bring them together to produce an agreed result. They are able to take ethical aspects into account when working on a topic. Students can work independently on new topics, evaluate information, draw practical conclusions, develop new solutions and take social, ecological and economic aspects into account. In this way, the objectives associated with the civil society commitment to promote the holistic education of students are achieved.

Literature: Depends on the chosen topic.

Type:

- Seminar
- Self-study

Module Examination

Requirements for Admission to the Module Exam: Formal: —
Content related: —

Final grade: PLS 50%, PLR 50%, A scientific seminar paper (10-20 pages) must be written on the respective topic and a seminar presentation (15min+5min discussion) must be given. The registration deadline for the seminar can be found on the registration form. The deadline for submitting the seminar paper is the last weekday in February in the winter semester and August 15 in the summer semester. The seminar cannot be deregistered.

Auxiliary means: The resources used must be named in the written work.

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56104: Seminar *professors, scientific staff of the faculty*				
5	2	1	S	PLR, PLS

Comments

Paper and presetation can be provided in English or German

Projekt

56008

Module Number	56008
Module Manager	program coordinator
E-Mail	roy.oberhauser@hs-aalen.de
Credits	10
Workload Class	30
Workload Self-Study	270
Offered	Winter term, Summer term
Modul Type	Mandatory
Language	English
Use in other SG	
Module Duration	1 Semester

Participation Requirements: Formal: minimum 20 CP from the courses of the Master's degree program
Content related: —

Module Objectives

Course Content: Depends on the topic.

Professional Competence: General: Students deepen their knowledge in their area of application/competence by working on a project in this area.

Depends on the topic.

Interdisciplinary Competence: Students are able to design, plan, prepare and carry out projects. They can argue scientifically, document a topic scientifically and discuss it professionally.

Students can independently work on new topics, evaluate information, draw practical conclusions, develop new solutions and take into account societal/social as well as ecological and economic aspects. In this way, the objectives associated with the civil society commitment to promote the holistic education of students are achieved.

Literature:

Type:

- Project work

Module Examination

Requirements for Admission to the Module Exam:

Final grade: PLP, 100%, A final scientific report must be prepared on the respective topic. The final report must contain, among other things, the initial project planning and, if necessary, justify any deviations from it. The application deadline for the project can be found on the application form. The deadline for submitting the final report is the last weekday in February in the winter semester and August 15 in the summer semester. Project work cannot be deregistered.

Auxiliary means:

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56204: Projekt *professors, scientific staff with an equivalent degree*				
10	2	2	P	PLP

Comments

The scientific report can be prepared in English or German

Kompetenzbereich 1

Module Number	56009
Module Manager	program coordinator
E-Mail	roy.oberhauser@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	Winter term, Summer term
Modul Type	Mandatory
Language	Englisch
Use in other SG	
Module Duration	1 Semester

Participation Requirements: Formal: —
Content related: —

Module Objectives

Course Content: Depends on the chosen subject.

The central topics of the "Machine Learning & Data Analytics" Master's degree program are cross-cutting issues that are important for many areas. The course therefore accepts students with Bachelor's degrees from various fields.

The area of competence is intended to combine the knowledge acquired in the Bachelor's degree with the cross-cutting topic of Machine Learning & Data Analytics. The area of competence consists of two competence subjects (called area of competence 1 and 2).

At the beginning of their studies, students must define their area of competence analogous to the subject area of their first professionally qualifying degree. The elective subject from the Master's area of competence 1 must match this area of competence. In this way, the previously acquired knowledge is combined with the cross-cutting topics of Machine Learning & Data Analytics.

Professional Competence: General: Students are able to integrate methods of machine learning and data analysis into applications from their area of expertise.

Depends on the chosen subject

Interdisciplinary Competence: Students are able to design, plan, prepare and carry out projects. They can argue scientifically, document a topic scientifically and discuss it

professionally.

Literature: Depends on the choosen module

Type:

- Lecture
- Excercise

Module Examination

Requirements for Admission to the Module Exam: Formal: —
Content related: —

Final grade: According to the specifications of the selected module

Auxiliary means:

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56105: Wahlvorlesung aus dem Master-Kompetenzbereich 1 *NN*				
5	4	1	VÜ	Depends on the chosen module

Comments

There are different options for elective subjects from the Master's competence area 1:

1. There will be explicit electives offered by the professors of our faculty. These can be found in the course schedule as well as in a list published on the website of the master's course.
2. The modules of our computer science master's course (MIN) can be chosen as electives.
3. The elective subject can be chosen from the entire Master's program at Aalen University, but must be approved by the Program Coordinator or Examination Board.

It is possible to choose modules taught in german language.

Wahlpflichtmodul

56011

Module Number	56011
Module Manager	program coordinator
E-Mail	roy.oberhauser@hs-aalen.de
Credits	5
Workload Class	60
Workload Self-Study	90
Offered	Winter term, Summer term
Modul Type	Mandatory
Language	English
Use in other SG	
Module Duration	1 Semester

Participation Requirements: Formal: —
Content related: —

Module Objectives

Course Content: Depends on the chosen module

Professional Competence: Depends on the chosen module

Interdisciplinary Competence: Depends on the chosen module

Literature: Depends on the chosen module

Type:

- Depends on the chosen module

Module Examination

Requirements for Admission to the Module Exam: Formal: —
Content related: —

Final grade: According to the specifications of the selected module

Auxiliary means: Depends on the chosen module

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
56106: Wahlvorlesung aus dem Wahlangebot des Studiengangs oder dem Masterangebot der Hochschule *NN*				
5	4	1	V	Depends on the chosen module

Comments

There are different options for elective subjects:

1. There will be explicit electives offered by the professors of our faculty. These can be found in the course schedule as well as in a list published on the website of the master's course.
2. The modules of our computer science master's course (MIN) can be chosen as electives.
3. The elective subject can also be chosen from the entire range of master's courses offered at Aalen University, but must be approved by the Program Coordinator or Examination Board.

It is possible to choose modules taught in german language.

Masterarbeit

9999

Module Number	9999
Module Manager	program coordinator
E-Mail	roy.oberhauser@hs-aalen.de
Credits	30
Workload Class	
Workload Self-Study	900
Offered	Winter term, Summer term
Modul Type	Mandatory
Language	English
Use in other SG	
Module Duration	1 Semester

Participation Requirements: Formal: Min. 50 CP from the courses of the Master's degree program
Content related: —

Module Objectives

Course Content: Depends on the chosen topic.

Professional Competence: Students are able to apply and combine the knowledge they have acquired and supplement it with independent research by independently solving a complex task from their area of application or competence and presenting and defending their solution in a colloquium.

Interdisciplinary Competence: Students can obtain information that goes beyond the course content and is relevant to their task and can integrate this into their existing knowledge. They can place their work in the context of the respective field and differentiate it from comparable work and approaches.

Literature:

Type:

- Project work

Module Examination

Requirements for Admission to the Module Exam: Formal: Min. 50 CP from the courses of the Master's degree program
Content related: —

Final grade: PLP, Master Thesis 80%, Colloquium 20%, A written thesis must be prepared and the topic of the Master's thesis must be presented and defended in a colloquium.

Auxiliary means:

Included Courses

CP	SWS	Semester	Type	Type and Duration of Proof of Performance
9999: Masterarbeit *Professors of the faculty*				
30		3	P	PLP

Comments

Thesis and Colloquium can be processed in English or German