MODULE HANDBOOK

Master of Science

Master Machine Learning Modeling (FS-OI-EU-MAML-60)

60 CP

Distance Learning

INTERNATIONAL
UNIVERSITY OF
APPLIED SCIENCES

Contents

Module DLMMTHES: Master Thesis

1. Semester

Machine Learning

Module Code: DLMDSML

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSAM01, DLMDSPWP01	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimum 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Visieu Lac (Machine Learning)

Contributing Courses to Module

- Machine Learning (DLMDSML01)

Module Exam Type

Module Exam	Split Exam
Study Format: myStudies Exam, 90 Minutes Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Supervised, unsupervised, and reinforcement learning approaches
- Regression and classification learning problems
- Estimation of functional dependencies via regression techniques
- Data clustering
- Support vector machines, large margin classification
- Decision tree learning

Learning Outcomes

Machine Learning

On successful completion, students will be able to

- know different machine learning model classes.
- comprehend the difference between supervised, unsupervised, and reinforcement learning methods.
- understand common machine learning models.
- analyze trade-offs in the application of different models.
- appropriately choose machine learning models according to a given task.

Links to other Modules within the Study Program	**Links to other Study Programs of the University**
This module is similar to other modules in the fields of Data Science & Artificial Intelligence	All Master Programs in the IT & Technology field

Machine Learning

Course Code: DLMDSML01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSAM01, DLMDSPWP01

Course Description

Machine learning is a field of scientific study concerned with algorithmic techniques that enable machines to learn performance on a given task via the discovery of patterns or regularities in exemplary data. Consequently, its methods commonly draw upon a statistical basis in conjunction with the computational capabilities of modern computing hardware. This course aims to acquaint the student with the main branches of machine learning and provide a thorough introduction to the most widely used approaches and methods in this field.

Course Outcomes

On successful completion, students will be able to

- know different machine learning model classes.
- comprehend the difference between supervised, unsupervised, and reinforcement learning methods.
- understand common machine learning models.
- analyze trade-offs in the application of different models.
- appropriately choose machine learning models according to a given task.

Contents

1. Introduction to Machine Learning
   - 1.1 Regression & Classification
   - 1.2 Supervised & Unsupervised Learning
   - 1.3 Reinforcement Learning
2. Clustering
   - 2.1 Introduction to clustering
   - 2.2 K-Means
   - 2.3 Expectation Maximization
   - 2.4 DBScan
   - 2.5 Hierarchical Clustering
3. Regression
   - 3.1 Linear & Non-linear Regression

3.2 Logistic Regression
3.3 Quantile Regression
3.4 Multivariate Regression
3.5 Lasso & Ridge Regression

4. Support Vector Machines
   4.1 Introduction to Support Vector Machines
   4.2 SVM for Classification
   4.3 SVM for Regression

5. Decision Trees
   5.1 Introduction to Decision Trees
   5.2 Decision Trees for Classification
   5.3 Decision Trees for Regression

6. Genetic Algorithms
   6.1 Introduction to Genetic Algorithms
   6.2 Applications of Genetic Algorithms

Literature

Compulsory Reading

Further Reading

- Akerkar, R., & Sajja, P. S. (2016). Intelligent techniques for data science. Springer International Publishing.
- Hodeghatta, U. R., & Nayak, U. (2017). Business analytics using R- A practical approach. Apress Publishing.
- Lahoz-Beltra, R. (2016). SGA: Simple Genetic Algorithm (SGA) in Python.
- Runkler, T. A. (2012). Data analytics: Models and algorithms for intelligent data analysis. Springer Vieweg Press.
- Skiena, S. S (2017). The data science design manual. Springer International Publishing. Database: Springer eBook Package English Computer Science.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Practice Exam
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Online Tests
	☑ Audio	
	☑ Slides	

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Practice Exam
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Online Tests
	☑ Audio	
	☑ Slides	

Deep Learning

Module Code: DLMDSDL

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSAM01, DLMDSPWP01, DLMDSML01	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimum 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Visieu Lac (Deep Learning)

Contributing Courses to Module

- Deep Learning (DLMDSDL01)

Module Exam Type

Module Exam	Split Exam
Study Format: myStudies Oral Assignment Study Format: Distance Learning Oral Assignment	

Weight of Module

see curriculum

Module Contents

- Introduction to neural networks and deep learning
- Network architectures
- Neural network training
- Alternative training methods
- Further network architectures

Learning Outcomes

Deep Learning

On successful completion, students will be able to

- comprehend the fundamental building blocks of neural networks.
- understand concepts in deep learning.
- analyze the relevant deep learning architecture in a wide range of application scenarios.
- create deep learning models.
- utilize alternative methods to train deep learning models.

Links to other Modules within the Study Program	**Links to other Study Programs of the University**
This module is similar to other modules in the fields of Data Science & Artificial Intelligence	All Master Programs in the IT & Technology field

Deep Learning

Course Code: DLMDSDL01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSAM01, DLMDSPWP01, DLMDSML01

Course Description

Neural networks and deep learning approaches have revolutionized the fields of data science and artificial intelligence in recent years, and applications built on these techniques have reached or surpassed human performance in many specialized applications.After a short review of the origins of neural networks and deep learning, this course will cover the most common neural network architectures and discuss in detail how neural networks are trained using dedicated data samples, avoiding common pitfalls such as overtraining.The course includes a detailed overview of alternative methods to train neural networks and further network architectures which are relevant in a wide range of specialized application scenarios.

Course Outcomes

On successful completion, students will be able to

- comprehend the fundamental building blocks of neural networks.
- understand concepts in deep learning.
- analyze the relevant deep learning architecture in a wide range of application scenarios.
- create deep learning models.
- utilize alternative methods to train deep learning models.

Contents

1. Introduction to Neural Network and Deep Learning
   - 1.1 The Biological Brain
   - 1.2 Perceptron and Multi-Layer Perceptrons
2. Network Architectures
   - 2.1 Feed-Forward Networks
   - 2.2 Convolutional Networks
   - 2.3 Recurrent Networks, Memory Cells and LSTMs
3. Neural Network Training
   - 3.1 Weight Initialization and Transfer Function
   - 3.2 Backpropagation and Gradient Descent
   - 3.3 Regularization and Overtraining

4. Alternative Training Methods
   - 4.1 Attention
   - 4.2 Feedback Alignment
   - 4.3 Synthetic Gradients
   - 4.4 Decoupled Network Interfaces

5. Further Network Architectures
   - 5.1 Generative Adversarial Networks
   - 5.2 Autoencoders
   - 5.3 Restricted Boltzmann Machines
   - 5.4 Capsule Networks
   - 5.5 Spiking Networks

Literature

Compulsory Reading

Further Reading

- Chollet, F. (2021). Deep learning with Python. 2nd edition. Shelter Island, NY. Manning Publications.
- Geron, A. (2022). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. 3rd edition. Boston, MA, O'Reilly Media Inc.
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. Boston, MA: MIT Press.
- Russel, S., & Norvig, P. (2022). Artificial intelligence – A modern approach (4th ed.). Essex. Pearson.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Guideline

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video	☑ Online Tests ☑ Guideline

Reinforcement Learning

Module Code: DLMAIRIL

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSAM01, DLMDSPWP01, DLMDSML01, DLMDSDL01	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimum 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Max Pumperla (Reinforcement Learning)

Contributing Courses to Module

- Reinforcement Learning (DLMAIRIL01)

Module Exam Type

Module Exam	Split Exam
Study Format: myStudies Written Assessment: Written Assignment Study Format: Distance Learning Written Assessment: Written Assignment	

Weight of Module

see curriculum

Module Contents

- Introduction to reinforcement learning
- Markov chains
- Bandit
- Q-Learning
- Reinforcement learning approaches

Learning Outcomes

Reinforcement Learning

On successful completion, students will be able to

- understand the concepts of reinforcement learning.
- analyze Markov decision processes.
- evaluate value functions, actions and policies.
- apply Q-Learning methods to reinforcement learning problems.
- summarize model-free and model-based approaches.
- evaluate the tradeoff between exploitation and exploration.

Links to other Modules within the Study Program	**Links to other Study Programs of the University**
This module is similar to other modules in the fields of Data Science & Artificial Intelligence	All Master Programs in the IT & Technology field

Reinforcement Learning

Course Code: DLMAIRIL01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSAM01, DLMDSPWP01, DLMDSML01, DLMDSDL01

Course Description

Reinforcement learning allows computers to derive problem-solving strategies without being explicitly programmed for the specific task, similar to the way humans and animals learn.After introducing the concepts of reinforcement learning, the course discusses the properties of Markov chains and single- and multi-armed bandits in detail. Special attention is given to the understanding of value functions and discounted value functions.The course connects reinforcement learning with neural networks and deep learning and discusses how Q-Learning approaches can be used to utilize deep learning methods in reinforcement learning problems, including extensions such as double Q-Learning, hierarchical learning, and actor-critic learning.Finally, the course discusses reinforcement learning approaches such as model-free and model-based learning and the tradeoff between exploration and exploitation.

Course Outcomes

On successful completion, students will be able to

- understand the concepts of reinforcement learning.
- analyze Markov decision processes.
- evaluate value functions, actions and policies.
- apply Q-Learning methods to reinforcement learning problems.
- summarize model-free and model-based approaches.
- evaluate the tradeoff between exploitation and exploration.

Contents

1. Introduction to Reinforcement Learning
   - 1.1 Understanding Reinforcement Learning
   - 1.2 Components of Reinforcement Learning Systems
2. Markov Chains
   - 2.1 Markov Decision Process & Markov Property
   - 2.2 Value Functions and Discounted Value Functions
   - 2.3 General Utility Function
   - 2.4 Actions & Policy
   - 2.5 Bellman’s Equation
   - 2.6 Value Iteration

2.7 Markov Chain Monte Carlo (MCMC)

3. Bandit
   - 3.1 Single-Arm Bandit
   - 3.2 Multi-Arm Bandit

4. Q-Learning
   - 4.1 Time-difference Learning
   - 4.2 Reinforcement Learning with Neural Networks & Deep Q Learning
   - 4.3 Experience Replay
   - 4.4 Double Q-Learning
   - 4.5 Delayed Sparse Rewards
   - 4.6 Hierarchical Learning
   - 4.7 Value- vs Policy-Based Learning
   - 4.8 Actor Critic Learning

5. Reinforcement Learning Approaches
   - 5.1 Model-Free Learning
   - 5.2 Model-Based Learning
   - 5.3 Exploration vs Exploitation

Literature

Compulsory Reading

Further Reading

- Bertsekas, D. P. (2019). Reinforcement learning and optimal control. Athena Scientific
- Sutton, R. S., & Barto, A. G. (1998). Reinforcement learning: An introduction. MIT Press.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Guideline

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Guideline

Leveraging Data Sources & Data Mining

Module Code: DLMDMEDM1

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimaldauer: 1 Semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Frank Passing (Leveraging Data Sources & Data Mining)

Contributing Courses to Module

- Leveraging Data Sources & Data Mining (DLMDMEDM01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Data Mining Process
- Data Quality and Data Preparation
- Data Retrieval Strategies
- Types of Data Sources
- Data Mining Techniques
- Web Mining
- Data Economy
- Legal Regulations and Usage Policies

Learning Outcomes

Leveraging Data Sources & Data Mining

On successful completion, students will be able to

- explain the main concepts of data mining.
- know different strategies of data retrieval, the techniques of data preparation and data quality assurance.
- comprehend the various types of data sources used in data mining.
- apply the main techniques of data and web mining.
- summarize the key players and components of data economy.
- describe the legal regulations and usage policies in data mining.

Links to other Modules within the Study Program	Links to other Study Programs of the University
This module is similar to other modules in the field of Data Science & Artificial Intelligence	All Master Programs in the IT & Technology field

Leveraging Data Sources & Data Mining

Course Code: DLMDMEDM01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	none

Course Description

This course provides an overview of data mining and its key aspects and methods. For this purpose, data mining processes, data retrieval strategies and data quality and preparation methods are introduced, the nature of data sources is learned, and some important data mining and web scraping techniques are discussed. In addition, the concepts of data economy and the legal requirements and usage guidelines associated with data mining are discussed.

Course Outcomes

On successful completion, students will be able to

- explain the main concepts of data mining.
- know different strategies of data retrieval, the techniques of data preparation and data quality assurance.
- comprehend the various types of data sources used in data mining.
- apply the main techniques of data and web mining.
- summarize the key players and components of data economy.
- describe the legal regulations and usage policies in data mining.

Contents

1. Data Mining Process
   - 1.1 The Role of Data in Businesses
   - 1.2 Understanding Data
   - 1.3 Modeling
   - 1.4 Evaluation
   - 1.5 Deployment

2. Data Quality and Data Preparation
   - 2.1 Gathering Data
   - 2.2 Data Selection
   - 2.3 Data Cleansing
   - 2.4 Sparse Data and Missing Values
   - 2.5 Data Consistency

3. Data Retrieval Strategies
   - 3.1 Query Driven
   - 3.2 Mining Data Streams
   - 3.3 Large-Scale Data Mining
   - 3.4 Process Mining
   - 3.5 Information Extraction

4. Types of Data Sources
   - 4.1 APIs, Flat files and Unusual formats
   - 4.2 Relational Databases
   - 4.3 Non-relational Databases
   - 4.4 Streaming Data
   - 4.5 Open Data Sources

5. Data Mining Techniques
   - 5.1 Statistical Methods
   - 5.2 Machine Learning
   - 5.3 Data Warehousing
   - 5.4 Event Processing
   - 5.5 Real-time Processing

6. Web Mining
   - 6.1 Information Retrieval
   - 6.2 Web Content Mining
   - 6.3 Web Structure and Usage Mining
   - 6.4 Web Search and Spamdexing
   - 6.5 Access and Mine the Data Lake

7. Data Economy
   - 7.1 Data Producers and Aggregators
   - 7.2 Data Monetization
   - 7.3 Internet of Things
   - 7.4 Data Mining in Industry 4.0
   - 7.5 Big Data

8. Legal Regulations and Usage Policies
   - 8.1 General Data Protection Regulation
   - 8.2 Personal Information

8.3 Legal Basis for Data Processing
8.4 Data Protection and Transparency
8.5 Copyright Compliance

Literature

Compulsory Reading

Further Reading

- Bhatia, P. (2019). Data Mining and Data Warehousing: Principles and Practical Techniques. Cambridge University Press.
- Bramer, M. (2020). Principles of Data Mining. Springer.
- Rajaraman, A., & Ullman, J. (2020). Mining of Massive Datasets. Cambridge University Press.
- Tan, P.-N., Steinbach, M., Kumar, V., & Karpatne, A. (2019). Introduction to Data Mining. Addison Wesley.
- Witten, I. H., & Frank, E. (2016). Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann Publishers.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Data Warehousing, Pipelines and Orchestration

Module Code: DLMDMDWPO

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimum 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Neil Arvin Bretana (Data Warehousing, Pipelines and Orchestration)

Contributing Courses to Module

- Data Warehousing, Pipelines and Orchestration (DLMDMDWPO01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Written Assessment: Case Study	

Weight of Module

see curriculum

Module Contents

- Principles of Data Warehousing
- Data Pipelines
- Orchestration Tools and Frameworks
- Solution Architecture
- Cloud Migration

Learning Outcomes

Data Warehousing, Pipelines and Orchestration

On successful completion, students will be able to

- explain and apply principles of data warehousing and data quality assessment.
- design and implement fully automated data processing pipelines.
- differentiate, assess, and use common data processing orchestration tools and frameworks.
- assess and evaluate different solution architectures for data warehousing and data processing orchestration.
- explain, evaluate, and apply common cloud migration techniques.
- reflect upon and discuss societal implications of automated large-scale data-processing systems.
- understand and implement requirements of interdisciplinary teams towards large-scale data processing pipelines and data warehousing.

Links to other Modules within the Study Program	Links to other Study Programs of the University
This module is similar to other modules in the field of Data Science & Artificial Intelligence	All Master Programs in the IT & Technology field

Data Warehousing, Pipelines and Orchestration

Course Code: DLMDMDWPO01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	none

Course Description

The responsibilities of a data manager expand beyond mere data storage and one-time processing tasks. To holistically manage data processing systems, it is necessary to orchestrate automated processes from a system-wide perspective, with respect to the whole data processing lifecycle and considering requirements of interdisciplinary teams as end-users of these systems. In this course, students learn the principles and practical application for Data Warehousing and Data Processing Orchestration. Definitions within this context are explained, such as Data Layers, Data Zones and Data Marts, and the distinction between Data Warehouses and Data Lakes is made. Within the context of data processing pipelines, principles such as the ETL and ELT approach are explained. Students learn the principles as well as the practical application of common cloud-based data processing orchestration tools and frameworks. They are enabled to efficiently perform tasks within this context by making use of solution architecture principles. With respect to societal implications of automated large-scale data processing, students are enabled to contribute to the public discussion about these in an academic and well-informed way. Finally, students learn about common cloud migration techniques and how to apply these principles in practice.

Course Outcomes

On successful completion, students will be able to

- explain and apply principles of data warehousing and data quality assessment.
- design and implement fully automated data processing pipelines.
- differentiate, assess, and use common data processing orchestration tools and frameworks.
- assess and evaluate different solution architectures for data warehousing and data processing orchestration.
- explain, evaluate, and apply common cloud migration techniques.
- reflect upon and discuss societal implications of automated large-scale data-processing systems.
- understand and implement requirements of interdisciplinary teams towards large-scale data processing pipelines and data warehousing.

Contents

1. Principles of Data Warehousing
   - 1.1 Data Schemas
   - 1.2 Data Warehouses

- 1.3 Data Lakes
- 1.4 Practical example of a Data Lake: AWS cloud technology
- 1.5 Checklist for Building or Modifying an Information Retrieval System

2. Data Pipelines
   - 2.1 Pipelines and Their Functionality
   - 2.2 ETL or ELT
   - 2.3 Triggers and Schedules

3. Orchestration Tools and Frameworks
   - 3.1 Airflow
   - 3.2 Google Cloud Composer
   - 3.3 Azure Data Factory
   - 3.4 Databricks

4. Solution Architecture
   - 4.1 Tasks and Responsibilities of the Solution Architect
   - 4.2 Solution Architecture Design
   - 4.3 Reference Architectures

5. Cloud Migration
   - 5.1 Lift and Shift
   - 5.2 Cloud-native
   - 5.3 Retain and Retire

Literature
Compulsory Reading
Further Reading ▪ Burns, B. (2018): Designing Distributed Systems: Patterns and Paradigms for Scalable, Reliable Services. O'Reilly, Sabastopol, CA. ▪ Cote, C. (2018): Hands-On Data Warehousing with Azure Data Factory: ETL techniques to load and transform data from various sources, both on-premises and on cloud. Packt Publishing, Birmingham, UK. ▪ Kleppmann, M. (2017): Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. O'Reilly, Sebastopol, CA. ▪ Richards, M./Ford, N. (2020): Fundamentals of Software Architecture. O'Reilly, Sebastopol, CA. ▪ Shrivastava, S. (2020): Solutions Architect's Handbook: Kick-start your solutions architect career by learning. Packt Publishing, Birmingham, UK. ▪ Uttamchandani, S. (2020): The Self-Service Data Roadmap. Democratize Data and Reduce Time to Insight. O'Reilly, Sebastopol, CA.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video	☑ Online Tests

Project: Machine Learning Libraries

Module Code: DLMMLPMLL

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimaldauer: 1 Semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Kristina Schaaff (Project: Machine Learning Libraries)

Contributing Courses to Module

- Project: Machine Learning Libraries (DLMMLPMLL01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Portfolio	

Weight of Module

see curriculum

Module Contents

Within this project-based course, students seamlessly integrate their previously gained knowledge into real-world applications. They leverage diverse Python libraries, translating their comprehension into precisely crafted code. All relevant artifacts from use case evaluation to the outcomes are to be documented.

Learning Outcomes

Project: Machine Learning Libraries

On successful completion, students will be able to

- transfer acquired theoretical knowledge to real-world case studies.
- know frameworks and libraries for training and prediction.
- build different ML models based on different data set and use cases, demonstrating fundamental understanding of each method and model.
- explain the difference of the models and reason behind the choice on the method based on dataset and use cases.
- critically evaluate the chosen method on their suitability for the use case and data in terms of applicability, performance, limitations.
- apply acquired theoretical knowledge to solve real-world challenges, selecting the suitable methods and libraries to address practical requirements.
- identify and utilize open data sources for benchmarking model performance.

Links to other Modules within the Study Program	**Links to other Study Programs of the University**
This module is similar to other modules in the field of Data Science & Artificial Intelligence	All Master Programs in the IT & Technology field

Project: Machine Learning Libraries

Course Code: DLMMLPMLL01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	none

Course Description

Throughout this course, students will acquire insights into the process of applying various Machine Learning (ML) libraries, encompassing training, prediction, evaluation, and visualization / explanation. Through real-world case studies, students will learn to make informed decisions about libraries and methods, evaluate model performance, explain the model using visualization libraries, and translate theoretical knowledge into real-life scenarios.

Course Outcomes

On successful completion, students will be able to

- transfer acquired theoretical knowledge to real-world case studies.
- know frameworks and libraries for training and prediction.
- build different ML models based on different data set and use cases, demonstrating fundamental understanding of each method and model.
- explain the difference of the models and reason behind the choice on the method based on dataset and use cases.
- critically evaluate the chosen method on their suitability for the use case and data in terms of applicability, performance, limitations.
- apply acquired theoretical knowledge to solve real-world challenges, selecting the suitable methods and libraries to address practical requirements.
- identify and utilize open data sources for benchmarking model performance.

Contents

- In this course, students will demonstrate their proficiency with a range of well-known Python ML libraries. They will utilize pandas for effective data wrangling, scikit-learn for training and prediction using classical ML methods, and either TensorFlow/Keras or PyTorch for deep learning tasks. Visualizations will be crafted using seaborn, matplotlib, Tensor Board and optionally tools like LIME and SHAP for model interpretability. Furthermore, the course delves into techniques for fine-tuning hyperparameters and applying heuristics using the libraries. These concepts will be explored through real-world case studies, providing hands-on experience. Additionally, the students will be introduced students to low-code and no-code alternatives, presenting a contrast with traditional Python library coding. This exploration will encompass aspects like tuning capabilities and strategies for model/library selection. Ultimately, students will adeptly apply their theoretical foundation to effectively tackle challenges and limitations that arise in real-world applications.

Literature
Compulsory Reading
Further Reading ▪ Géron, A. (2019). Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow. O'Reilly Media. ▪ Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press. ▪ McKinney, W. (2018). Python for Data Analysis. O'Reilly Media. ▪ Molnar, C. (2020). Interpretable Machine Learning. Leanpub ▪ Raschka, S., & Mirjalili, V. (2019). Python Machine Learning. Packt Publishing.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Portfolio

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
Tutorial Support ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	**Exam Preparation** ☑ Guideline

2. Semester

Applied Research

Module Code: DLMAF_E

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	None	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimum 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Evangelos Zois (Applied Research)

Contributing Courses to Module

- Applied Research (DLMAF01_E)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Written Assessment: Written Assignment	

Weight of Module

see curriculum

Module Contents

- Fundamentals of Empirical Research
- The Empirical Research Process
- Qualitative Survey Research
- Standardized Survey Research
- Experimental Research
- Specifics of Research with Secondary and Observational Data

Learning Outcomes

Applied Research

On successful completion, students will be able to

- evaluate the type and quality of empirical research and of concrete empirical research results based on relevant criteria.
- identify appropriate data and research methods to empirically address a specific problem or research question.
- name and critically compare the process steps as well as the potentials, aims and limitations of different quantitative and qualitative research methods.
- recognize and consider basic ethical and legal aspects while conducting empirical research.
- design an empirical and theory-based study on their own to adequately address a specific applied research problem.

Links to other Modules within the Study Program	**Links to other Study Programs of the University**
This module is similar to other modules in the field of Methods	All Master Programs in the Business & Management field

Applied Research

Course Code: DLMAF01_E

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	None

Course Description

The course teaches central concepts and methods of applied empirical research. The students acquire profound knowledge to evaluate the quality as well as the limitations of different empirical research approaches. First, students learn the central theoretical foundations of empirical research and the central process steps of empirical research projects. In doing so, students are also sensitised to the ethical and legal challenges. The course deals in depth with the application of central qualitative and quantitative research methods, for each of which the central goals and decision areas, their strengths, and weaknesses, as well as practical recommendations for application are discussed. The course enables students to develop an empirical study for an applied problem in their field or professional environment and to critically evaluate the quality of empirical findings as well as their validity.

Course Outcomes

On successful completion, students will be able to

- evaluate the type and quality of empirical research and of concrete empirical research results based on relevant criteria.
- identify appropriate data and research methods to empirically address a specific problem or research question.
- name and critically compare the process steps as well as the potentials, aims and limitations of different quantitative and qualitative research methods.
- recognize and consider basic ethical and legal aspects while conducting empirical research.
- design an empirical and theory-based study on their own to adequately address a specific applied research problem.

Contents

1. Fundamentals of Empirical Research
   - 1.1 Aims and Basic Approaches of Empirical Research
   - 1.2 Objectivity, Reliability, and Validity of Empirical Research
   - 1.3 Causality
2. The Empirical Research Process
   - 2.1 Determination of the Research Objective
   - 2.2 Choice of Research Design

Literature
Compulsory Reading
Further Reading ▪ Flick, U. (2018). An Introduction to Qualitative Research (6th edition). Sage. ▪ Gravetter, F. J., & Forzano, L. A. B. (2018). Research Methods for the Behavioral Sciences (6th edition. Cengage Learning. ▪ Quinlan, C., Babin, B., Carr, J. Griffin, M., & Zikmund, W. G. (2019). Business Research Methods (2nd edition). Cengage Learning. ▪ Vomberg, A., & Klarmann, M. (2021). Crafting Survey Research: A Systematic Process for Conducting Survey Research. In C. Homburg, M. Klarmann, & A. E. (Eds.), Handbook of market research (pp. 1-53). Springer.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Guideline

Data Modeling and Reporting

Module Code: DLMBIDMR

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	None	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimum 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Silke Vaas (Data Modeling and Reporting)

Contributing Courses to Module

- Data Modeling and Reporting (DLMBIDMR01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Basic Concepts
- Data Modeling Life Cycle
- Data Model Types
- Data Extraction Using SQL
- NoSQL Data Extraction
- Data Reporting
- Online Transactional Processing
- Online Analytical Processing

Learning Outcomes

Data Modeling and Reporting

On successful completion, students will be able to

- discuss the basic concepts of data modeling.
- comprehend the life cycle of data modeling.
- understand the different data model types.
- summarize the main SQL and NoSQL data extraction techniques.
- explain the main methods of online transaction processing.
- describe the main concepts of online analytical processing.
- explain what needs to be considered when providing a wide variety of data types with regard to data protection.
- explain which disciplines play an essential role in the context of applied data modeling and reporting.

Links to other Modules within the Study Program	Links to other Study Programs of the University
This module is similar to other modules in the fields of Data Science & Artificial Intelligence	All Master Programs in the IT & Technology field

Data Modeling and Reporting

Course Code: DLMBIDMR01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	None

Course Description

Interdisciplinary working methods and ways of thinking are often decisive for the success of sustainable IT solutions. The topic of business intelligence combines various areas from computer and natural sciences, as well as studies of business administration. This course provides an overview of data modeling and its key aspects and methods. To this end, data modeling concepts are introduced, the data modeling lifecycle is learned, and some important data modeling techniques and data extraction for SQL and NoSQL databases are presented. In addition, the concepts of online transactional processing and online analytical processing are discussed.

Course Outcomes

On successful completion, students will be able to

- discuss the basic concepts of data modeling.
- comprehend the life cycle of data modeling.
- understand the different data model types.
- summarize the main SQL and NoSQL data extraction techniques.
- explain the main methods of online transaction processing.
- describe the main concepts of online analytical processing.
- explain what needs to be considered when providing a wide variety of data types with regard to data protection.
- explain which disciplines play an essential role in the context of applied data modeling and reporting.

Contents

1. Basic Concepts
   - 1.1 Batch Data Processing
   - 1.2 Relational Data
   - 1.3 Non-Relational Data
   - 1.4 Streaming Data
   - 1.5 Big Data
2. Data Modeling Life Cycle
   - 2.1 Understand the Business
   - 2.2 Acquire and Explore Data

8.2 Basic Analytical Operations
8.3 Types of OLAP Systems
8.4 Multidimensional Processing
8.5 Hybrid Processin

Literature

Compulsory Reading

Further Reading

- Agiledata. (2021). Data Modeling 101. http://agiledata.org/essays/dataModeling101.html
- Jukic, N., Vrbsky, S., & Nestorov, S. (2016). Database Systems, Introduction to Databases and Data Warehouses. Prospect Press.
- Meier, A., & Kaufmann, M. (2019). SQL & NoSQL Databases - Models, Languages, Consistency Options and Architectures for Big Data Management. Springer.
- Molinaro, A., & de Graaf, R. (2020). SQL Cookbook: Query Solutions and Techniques for All SQL Users. O'Reilly UK Ltd.
- Vasilik, S. M. (2020). SQL Practice Problems: 57 beginning, intermediate, and advanced challenges for you to solve using a “learn-by-doing” approach.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**Online Tests:** yes
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	☑ Course Book ☑ Video ☑ Audio ☑ Slides	☑ Practice Exam ☑ Online Tests

Seminar: Sustainability, Ethics, and Law in Machine Learning

Module Code: DLMMLSSELML

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	5	150 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimaldauer: 1 Semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Kristina Schaaff (Seminar: Sustainability, Ethics, and Law in Machine Learning)

Contributing Courses to Module

- Seminar: Sustainability, Ethics, and Law in Machine Learning (DLMMLSSELML01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Written Assessment: Research Essay	

Weight of Module

see curriculum

Module Contents

The seminar covers topics concerning sustainability, ethics and how international law fits in participants gain critical understanding, methods knowledge, and practical skills necessary for responsible ML usage. Guided by real-world use cases, the seminar addresses privacy, bias, transparency, legality, and societal and environmental impact. A current list of topics will be provided.

Learning Outcomes

Seminar: Sustainability, Ethics, and Law in Machine Learning

On successful completion, students will be able to

- critically reflect on current research about sustainability, ethics and international IT Law.
- grasp the socio-cultural and environmental implications of Machine Learning systems.
- be aware of international ethical best-practices in Machine Learning practices.
- identify potential areas of bias and discrimination in Machine Learning practices and research possible solutions to minimize or mitigate them.
- effectively incorporate sustainability considerations in Machine Learning projects.
- exhibit cultural competence when designing or applying Machine Learning solutions in diverse global contexts.

Links to other Modules within the Study Program	Links to other Study Programs of the University
This module is similar to other modules in the field of Data Science & Artificial Intelligence	All Master Programs in the IT & Technology field

Seminar: Sustainability, Ethics, and Law in Machine Learning

Course Code: DLMMLSSELML01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	none

Course Description

In this course students will gain an in-depth look at the ethical, legal, and sustainable considerations of applying Machine Learning techniques. Through interactive teaching this seminar provides knowledge of methods, critical understanding, and practical skills necessary to commit to responsible usage of Machine Learning techniques. Based on different use cases participants will be guided through issues of privacy, bias, transparency, lawfulness, and social and environmental impact of Machine Learning. Insights from several disciplines, including AI, data sciences, ethics, and law are considered to allow for a holistic understanding. A current list of topics will be provided.

Course Outcomes

On successful completion, students will be able to

- critically reflect on current research about sustainability, ethics and international IT Law.
- grasp the socio-cultural and environmental implications of Machine Learning systems.
- be aware of international ethical best-practices in Machine Learning practices.
- identify potential areas of bias and discrimination in Machine Learning practices and research possible solutions to minimize or mitigate them.
- effectively incorporate sustainability considerations in Machine Learning projects.
- exhibit cultural competence when designing or applying Machine Learning solutions in diverse global contexts.

Contents

- The seminar will provide an overview to ethics, sustainability, and law in Machine Learning. Ethical and legal implications of Machine Learning Model deployments will be discussed, e.g., how to foster technological advancement while adhering to ethical standards. A critical understanding of possible bias in Machine Learning algorithms, data quality issues, explainability methods, privacy concerns and data protection approaches will be gained. Several case studies will be discussed in detail. The following topics will be available:
  - Use cases that reflect trustworthy and fair AI models and possible implications of biased AI models.

- Use cases around sustainable development of Machine Learning; to explore the environmental and societal impact of AI models and Machine Learning with a specific focus on the sustainable development goals.
- Use cases of sustainable development of Machine Learning with a specific focus on issues around the digital divide.
- Use cases that highlight the principles of ethical decision making in machine learning, including relevant ethical frameworks for machine learning application and best practices.
- Use cases to cover international regulations and legal challenges posed by Machine Learning, considering international frameworks and possible technologies such as secure and privacy preserving Machine Learning techniques.

Literature

Compulsory Reading

Further Reading

- Hidalgo, A., Gabaly, S., Morales-Alonso, G., & Urueña, A. (2020). The digital divide in light of sustainable development: An approach through advanced machine learning techniques. Technological forecasting and social change, 150, 119754.
- Jobin, A., Ienca, M., & Vayena, E. (2019). The global landscape of AI ethics guidelines. Nature machine intelligence, 1(9), 389-399.
- Kaissis, G. A., Makowski, M. R., Rückert, D., & Braren, R. F. (2020). Secure, privacy-preserving and federated machine learning in medical imaging. Nature Machine Intelligence, 2(6), 305-311.
- Le Quy, T., Roy, A., Iosifidis, V., Zhang, W., & Ntoutsi, E. (2022). A survey on datasets for fairness-aware machine learning. Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 12(3), e1452.
- Müller,V. C. (2020). Ethics of Artificial Intelligence and Robotics. In Edward Zalta (ed.), Stanford Encyclopedia of Philosophy. Palo Alto, Cal.: CSLI, Stanford University. pp. 1-70.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
Tutorial Support ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint	**Exam Preparation** ☑ Guideline

Master Thesis

Module Code: DLMMTHES

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	See current study and exam regulations (SPO)	MA	15	450 h

Semester / Term	Duration	Regularly offered in	Language of Instruction and Examination
see curriculum	Minimum 1 semester	WiSe/SoSe	English

Module Coordinator

Prof. Dr. Tianxiang Lu (Master Thesis) / Prof. Dr. Tianxiang Lu (Colloquium)

Contributing Courses to Module

- Master Thesis (DLMMTHES01)
- Colloquium (DLMMTHES02)

Module Exam Type

Module Exam	Split Exam
	Master Thesis • Study Format "Distance Learning": Master Thesis (90) • Study Format "myStudies": Master Thesis (90) Colloquium • Study Format "myStudies": Colloquium (10) • Study Format "Distance Learning": Colloquium (10)

Weight of Module

see curriculum

Module Contents

Master Thesis

- Written Master Thesis

Colloquium

- Thesis Defense

Learning Outcomes

Master Thesis

On successful completion, students will be able to

- work on a problem from their major field of study by applying the specialist and methodological skills they have acquired during their studies.
- analyse selected tasks with scientific methods, critically evaluate them and develop appropriate solutions under the guidance of an academic supervisor.
- record and analyse existing (research) literature appropriate to the topic of the Master's thesis.
- prepare a detailed written elaboration in compliance with scientific methods.

Colloquium

On successful completion, students will be able to

- present a problem from their field of study under consideration of academic presentation and communication techniques.
- reflect on the scientific and methodological approach chosen in the Master's thesis.
- actively answer subject-related questions from subject experts (experts of the Master's thesis).

Links to other Modules within the Study Program	Links to other Study Programs of the University
All modules in the Master Program	All Master Programs

Master Thesis

Course Code: DLMMTHES01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		13.5	See current study and exam regulations (SPO)

Course Description

The aim and purpose of the Master's thesis is to successfully apply the subject-specific and methodological competencies acquired during the course of study in the form of an academic dissertation with a thematic reference to the major field of study. The content of the Master's thesis can be a practical-empirical or theoretical-scientific problem. Students should prove that they can independently analyse a selected problem with scientific methods, critically evaluate it and work out proposed solutions under the subject-methodological guidance of an academic supervisor. The topic to be chosen by the student from the respective field of study should not only prove the acquired scientific competences, but should also deepen and round off the academic knowledge of the student in order to optimally align his professional abilities and skills with the needs of the future field of activity.

Course Outcomes

On successful completion, students will be able to

- work on a problem from their major field of study by applying the specialist and methodological skills they have acquired during their studies.
- analyse selected tasks with scientific methods, critically evaluate them and develop appropriate solutions under the guidance of an academic supervisor.
- record and analyse existing (research) literature appropriate to the topic of the Master's thesis.
- prepare a detailed written elaboration in compliance with scientific methods.

Contents

- Within the framework of the Master's thesis, the problem as well as the scientific research goal must be clearly emphasized. The work must reflect the current state of knowledge of the topic to be examined by means of an appropriate literature analysis. The student must prove his ability to use the acquired knowledge theoretically and/or empirically in the form of an independent and problem-solution-oriented application.

Literature
Compulsory Reading
Further Reading ▪ Bui, Y. N. (2013). How to Write a Master's Thesis (2nd ed.). SAGE Publications, Incorporated. ▪ Turabian, K. L. (2013). A Manual for Writers of Research Papers, theses, and dissertations (8th ed.). University of Chicago Press. ▪ Further subject specific literature

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Thesis

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Master Thesis

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
405 h	0 h	0 h	0 h	0 h	405 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Slides	☑ Guideline

Study Format myStudies

Study Format	Course Type
myStudies	Thesis

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Master Thesis

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
405 h	0 h	0 h	0 h	0 h	405 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Slides	☑ Guideline

Colloquium

Course Code: DLMMTHES02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		1.5	See current study and exam regulations (SPO)

Course Description

The colloquium will take place after submission of the Master's thesis. This is done at the invitation of the experts. During the colloquium, the students must prove that they have fully independently produced the content and results of the written work. The content of the colloquium is a presentation of the most important work contents and research results by the student, and the answering of questions by the experts.

Course Outcomes

On successful completion, students will be able to

- present a problem from their field of study under consideration of academic presentation and communication techniques.
- reflect on the scientific and methodological approach chosen in the Master's thesis.
- actively answer subject-related questions from subject experts (experts of the Master's thesis).

Contents

- The colloquium includes a presentation of the most important results of the Master's thesis, followed by the student answering the reviewers' technical questions.

Literature

Compulsory Reading

Further Reading

- Renz, K.-C. (2016): The 1 x 1 of the presentation. For school, study and work. 2nd edition, Springer Gabler, Wiesbaden.

Study Format myStudies

Study Format	Course Type
myStudies	Thesis Defense

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Colloquium

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
45 h	0 h	0 h	0 h	0 h	45 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Slides	☑ Guideline

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Thesis Defense

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Colloquium

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
45 h	0 h	0 h	0 h	0 h	45 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Slides	☑ Guideline