MODULE HANDBOOK

Master of Science

Master Artificial Intelligence (FS-FI-MAAI-120-01)

120 ECTS

Distance Learning and myStudies

KING'S CORNERSTONE INTERNATIONAL COLLEGE

In partnership with

INTERNATIONAL UNIVERSITY OF APPLIED SCIENCES

Classification: Non-consecutive

Contents

1. Semester

Module DLMAIAI: Artificial Intelligence
Module Description 11
Course DLMAIAI01: Artificial Intelligence 13

Module DLMDSAM: Advanced Mathematics
Module Description 17
Course DLMDSAM01: Advanced Mathematics 19

Module DLMDSUCE: Use Case and Evaluation
Module Description 23
Course DLMDSUCE01: Use Case and Evaluation 25

Module DLMAISAIS: Seminar: AI and Society
Module Description 29
Course DLMAISAIS01: Seminar: AI and Society 31

Module DLMDSAS: Advanced Statistics
Module Description 35
Course DLMDSAS01: Advanced Statistics 37

Module DLMAIPAIUC: Project: AI Use Case
Module Description 43
Course DLMAIPAIUC01: Project: AI Use Case 45

2. Semester

Module DLMDSPWP: Programming with Python
Module Description 53
Course DLMDSPWP01: Programming with Python 55

Module DLMDSML: Machine Learning
Module Description 59
Course DLMDSML01: Machine Learning 61

Module DLMDSDL: Deep Learning
Module Description 65
Course DLMDSDL01: Deep Learning 67

Module DLMAINLPCV: NLP and Computer Vision
Module Description....71
Course DLMAINLPCV01: NLP and Computer Vision....73

Module DLMAIIAC: Inference and Causality
Module Description....77
Course DLMAIIAC01: Inference and Causality....79

Module DLMAIRIL: Reinforcement Learning
Module Description....83
Course DLMAIRIL01: Reinforcement Learning....85

---

3. Semester

Module DLMDSSEDIS: Software Engineering for Data Intensive Sciences
Module Description....93
Course DLMDSSEDIS01: Software Engineering for Data Intensive Sciences....95

Module DLMAISCTAI: Seminar: Current Topics in AI
Module Description....99
Course DLMAISCTAI01: Seminar: Current Topics in AI....101

Module DLMAIEUIUX: UI/UX Expert
Module Description....105
Course DLMAIEUIUX01: User Interface and Experience....107
Course DLMAIEUIUX02: Project: Human Computer Interaction....110

Module DLMDSETPL: Technical Project Lead
Module Description....113
Course DLMBITPAM01: IT Project Management....115
Course DLMDSETPL01: Project: Technical Project Planning....118

Module DLMAIEAIS: AI Specialist
Module Description....121
Course DLMAIEAIS01: Advanced NLP and Computer Vision....123
Course DLMAIEAIS02: Project: NLP and Computer Vision....126

Module DLMDSEDE: Data Engineer
Module Description....129
Course DLMDSEDE01: Data Engineering....131
Course DLMDSEDE02: Project: Data Engineering....134

Module DLMAIEFT: Artificial Intelligence in FinTech
Module Description....137

Course DLMAIEFT01: Concepts of FinTechs and Artificial Intelligence 140
Course DLMAIEFT02: Fraud Detection FinTechs 144

Module DLMDSEAAD: Applied Autonomous Driving
Module Description 149
Course DLMDSEAAD01: Architectures of Self-Driving Vehicles 151
Course DLMDSEAAD02: Case Study: Localization, Motion Planning and Sensor Fusion 154

Module DLMAIESCM: Artificial Intelligence in Supply Chain Management
Module Description 159
Course DLMAIESCM01: Concepts of Artificial Intelligence in Supply Chain Management 161
Course DLMAIESCM02: Multi-Agent Systems 165

Module DLMAIEHCMI: AI in Healthcare and Medical Imaging
Module Description 169
Course DLMAIEHCMI01: AI in Healthcare 171
Course DLMAIEHCMI02: AI in Medical Imaging and Diagnostics 175

Module DLMAIEECMDF: AI in E-Commerce, Marketing and Demand Forecast
Module Description 179
Course DLMAIEECMDF01: Introduction to AI in E-Commerce and Marketing 181
Course DLMAIEECMDF02: Demand Forecast and Inventory Control 185

Module DLMAIEIAI: Industrial AI
Module Description 189
Course DLMAIEIAI01: AI in Production 191
Course DLMAIEIAI02: Project: Industrial Internet of Things 194

Module DLMAIWNLPVA: Natural Language Processing and Voice Assistants
Module Description 197
Course DLMAIWNLPVA01: Natural Language Processing 199
Course DLMAIWNLPVA02: Voice Assistants 202

Module DLMAIWFCV: Foundational Computer Vision
Module Description 205
Course DLMAIWFCV01: Image Processing and Low Level Vision 207
Course DLMAIWFCV02: Mid-Level Vision and Video 210

Module DLMMANE: Management
Module Description 213
Course DLMBLSE01: Leadership 216
Course DLMBSME01: Strategic Management 222

Module DLMBSPBE: Sales, Pricing and Brand Management
Module Description 227

Course DLMBSPBE01: Global Brand Management 230
Course DLMBSPBE02: Sales and Pricing 234

Module DLMBCBR: Consumer Behavior and Research
Module Description 239
Course DLMBCBR01: International Consumer Behavior 242
Course DLMBCBR02: Applied Marketing Research 246

Module DLMBCF: Corporate Finance
Module Description 251
Course DLMINRE01: Corporate Finance 254
Course DLMBCFIE01: Advanced Corporate Finance 259

Module DLMDSEIAC-01: Innovate and Change
Module Description 263
Course DLMBCM01: Change Management 267
Course DLMBIE01-01: Innovation and Entrepreneurship 271

Module DLMAIEAR: Advanced Robotics 4.0
Module Description 277
Course DLMAIEAR01: Industrial and Mobile Robots 279
Course DLMAIEAR02: Project: Collaborative Robotics 283

Module DLMAIERAFT: Robo Advisory and AI in FinTech
Module Description 285
Course DLMAIERAFT01: Robo Advisory 288
Course DLMAIERAFT02: AI in FinTech 292

Module DLMAIEFSCVAS: Functional Security and Computer Vision for Autonomous Systems
Module Description 295
Course DLMAIEFSCVAS01: Functional Security 297
Course DLMAIEFSCVAS02: Computer Vision for Autonomous Systems 300

Module DLMAIEADFP: AI and its Application in Demand Forecast and Procurement
Module Description 305
Course DLMAIEECMDF02: Demand Forecast and Inventory Control 308
Course DLMAIEADFP01: Artificial Intelligence in Procurement 312

Module DLMAIEMNMR: Medical NLP and Medical Robotics
Module Description 315
Course DLMAIEMNMR01: Medical NLP 317
Course DLMAIEMNMR02: Medical Robotics and Devices 321

Module DLMAIEAPRS: AI for Analytics, Personalization and Recommender Systems
Module Description 325

Course DLMAIEAPRS01: AI in Marketing and Analytics 327
Course DLMAIEAPRS02: Personalization and Recommender Systems 330

Module DLMAIEIACVAS: Industrial Automation and Computer Vision for Autonomous Systems
Module Description 333
Course DLMDSINDA01: Industrial Automation 335
Course DLMAIEFSCVAS02: Computer Vision for Autonomous Systems 339

Module DLMAIWNLPITE: NLP and Innovative Technologies in Education
Module Description 343
Course DLMAIWNLPITE01: NLP in Education 345
Course DLMAIWNLPITE02: NLP for Accessibility 348

Module DLMAIWCCV: Cognitive Computer Vision
Module Description 351
Course DLMAIWCCV01: High-Level Vision 353
Course DLMAIWCCV02: Project: Computer Vision 356

---

4. Semester

Module MMTHE: Master Thesis
Module Description 363
Course MMTHE01: Master Thesis 365
Course MMTHE02: Colloquium 369

2022-08-01

1. Semester

Artificial Intelligence

Module Code: DLMAIAI

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. Ulrich Kerzel (Artificial Intelligence)

Contributing Courses to Module

- Artificial Intelligence (DLMAIAI01)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents

- History of AI
- AI application areas
- Expert systems
- Neuroscience
- Modern AI systems

Learning Outcomes

Artificial Intelligence

On successful completion, students will be able to

- remember the historical developments in the field of artificial intelligence.
- analyze the different application areas of artificial intelligence.
- comprehend expert systems.
- apply Prolog to simple expert systems.
- comprehend the brain and cognitive processes from a neuro-scientific point of view.
- understand modern developments in artificial intelligence.

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 Bachelor Programmes in the IT & Technology field.

Artificial Intelligence

Course Code: DLMAIAI01

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

Course Description

The quest for artificial intelligence has captured humanity's interest for many decades and has been an active research area since the 1960s. This course will give a detailed overview of the historical developments, successes, and set-backs in AI, as well as the development and use of expert systems in early AI systems.In order to understand cognitive processes, the course will give a brief overview of the biological brain and (human) cognitive processes and then focus on the development of modern AI systems fueled by recent developments in hard- and software. Particular focus will be given to discussion of the development of "narrow AI" systems for specific use cases vs. the creation of general artificial intelligence.The course will give an overview of a wide range of potential application areas in artificial intelligence, including industry sectors such as autonomous driving and mobility, medicine, finance, retail, and manufacturing.

Course Outcomes

On successful completion, students will be able to

- remember the historical developments in the field of artificial intelligence.
- analyze the different application areas of artificial intelligence.
- comprehend expert systems.
- apply Prolog to simple expert systems.
- comprehend the brain and cognitive processes from a neuro-scientific point of view.
- understand modern developments in artificial intelligence.

Contents

1. History of AI
   - 1.1 Historical Developments
   - 1.2 AI Winter
   - 1.3 Notable Advances in AI
2. Expert Systems
   - 2.1 Overview Over Expert Systems
   - 2.2 Introduction to Prolog

3. Neuroscience
   - 3.1 The (Human) Brain
   - 3.2 Cognitive Processes

4. Modern AI Systems
   - 4.1 Recent Developments in Hard- and Software
   - 4.2 Narrow vs General AI
   - 4.3 NLP and Computer Vision

5. AI Application Areas
   - 5.1 Autonomous Vehicles & Mobility
   - 5.2 Personalized Medicine
   - 5.3 FinTech
   - 5.4 Retail & Industry

Literature

Compulsory Reading

Further Reading

- Russell, S. & Norvig, P. (2010). Artificial intelligence: a modern approach (3rd ed.). Upper Saddle River, NJ: Prentice Hall.
- Lucas, P.J.F & Van der Gaag, L. (1991). Principles of expert systems. Amsterdam: Addison Wesley (copyright returned to author).
- Clocksin, W.F. & Mellish, C.S. (2003). Programming in Prolog (4th ed.). Berlin: Springer-Verlag.
- Ward, J. (2015). The student's guide to cognitive neuroscience. (3rd ed.). New York, NY: Psychology Press.
- Frankish, K & Ramsey, W.M. (Eds.) (2012). The Cambridge handbook of cognitive science. Cambridge: Cambridge University Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Advanced Mathematics

Module Code: DLMDSAM

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. Eric Guiffo Kaigom (Advanced Mathematics)

Contributing Courses to Module

- Advanced Mathematics (DLMDSAM01)

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

- Calculus
- Integral transformations
- Vector algebra
- Vector calculus
- Matrices and vector spaces
- Information theory

Learning Outcomes

Advanced Mathematics

On successful completion, students will be able to

- remember the fundamental rules of differentiation and integration.
- apply integration and differentiation techniques to vectors and vector fields.
- analyze matrix equations.
- understand the generalization of vectors to tensors.
- evaluate different metrics from information theoretical perspectives.

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 Programmes in the Business & Management field.

Advanced Mathematics

Course Code: DLMDSAM01

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

Course Description

Modern techniques to analyze data and derive predictions for future events are deeply rooted in mathematical techniques.The course builds a solid base to understand the concepts behind advanced algorithms used to process, analyze, and predict data and observations and enables students to follow future research, especially in the fields of data-intensive sciences.The course reviews differentiation and integration and then discusses partial differentiation, differentiation, vector algebra and vector calculus. Matrix calculation and vector spaces are fundamental to many modern data processing algorithms and are discussed in detail. Calculations based on Tensors are introduced.Common metrics are discussed from an informational, theoretical point of view.

Course Outcomes

On successful completion, students will be able to

- remember the fundamental rules of differentiation and integration.
- apply integration and differentiation techniques to vectors and vector fields.
- analyze matrix equations.
- understand the generalization of vectors to tensors.
- evaluate different metrics from information theoretical perspectives.

Contents

1. Calculus
   - 1.1 Differentiation & Integration
   - 1.2 Partial Differentiation & Integration
   - 1.3 Vector Analysis
   - 1.4 Calculus of Variations
2. Integral Transformations
   - 2.1 Convolution
   - 2.2 Fourier Transformation

3. Vector Algebra
   - 3.1 Scalars and Vectors
   - 3.2 Addition, Subtraction of Vectors
   - 3.3 Multiplication of Vectors, Vector Product, Scalar Product

4. Vector Calculus
   - 4.1 Integration of Vectors
   - 4.2 Differentiation of Vectors
   - 4.3 Scalar and Vector Fields
   - 4.4 Vector Operators

5. Matrices and Vector Spaces
   - 5.1 Basic Matrix Algebra
   - 5.2 Determinant, Trace, Transpose, Complex, and Hermitian Conjugates
   - 5.3 Eigenvectors and Eigenvalues
   - 5.4 Diagonalization
   - 5.5 Tensors

6. Information Theory
   - 6.1 MSE
   - 6.2 Gini Index
   - 6.3 Entropy, Shannon Entropy, Kulback Leibler Distance
   - 6.4 Cross Entropy

Literature

Compulsory Reading

Further Reading

- Riley, K. F., Hobson, M. P, & Bence, S. J. (2006). Mathematical methods for physics and engineering (2nd ed.). Cambridge University Press.
- Strang, G. (2016). Introduction to linear algebra. Wellesley-Cambridge Press .

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

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

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Use Case and Evaluation

Module Code: DLMDSUCE

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. Ulrich Kerzel (Use Case and Evaluation)

Contributing Courses to Module

- Use Case and Evaluation (DLMDSUCE01)

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

- Use case evaluation
- Model-centric evaluation
- Business-centric evaluation
- Monitoring
- Avoiding common fallacies
- Change management

Learning Outcomes

Use Case and Evaluation

On successful completion, students will be able to

- analyze use cases and their requirements regarding the project objectives.
- apply common metrics to evaluate predictions.
- evaluate key performance indicators to assess projects from a business perspective.
- create monitoring tools that can be used to constantly evaluate the status quo of a project.
- understand common fallacies and how to avoid them.

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 Programms in the IT & Technology fields

Use Case and Evaluation

Course Code: DLMDSUCE01

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

Course Description

The evaluation and definition of use cases is the fundamental groundwork from which the projects can be defined. This does not only include the scope and technical requirements of a project but also how value can be derived from the project. A crucial aspect is the definition of what makes a project successful, both in terms of a technical evaluation as well as a business centric perspective and how the status quo can be monitored effectively during the progress of a project. The course also discusses how to avoid common fallacies and understand the implications of introducing data-driven decisions into traditional management structures.

Course Outcomes

On successful completion, students will be able to

- analyze use cases and their requirements regarding the project objectives.
- apply common metrics to evaluate predictions.
- evaluate key performance indicators to assess projects from a business perspective.
- create monitoring tools that can be used to constantly evaluate the status quo of a project.
- understand common fallacies and how to avoid them.

Contents

1. Use Case Evaluation
   - 1.1 Identification of Use Cases
   - 1.2 Specifying Use Case Requirements
   - 1.3 Data Sources and Data Handling Classification
2. Model-centric Evaluation
   - 2.1 Common Metrics for Regression and Classification
   - 2.2 Visual Aides
3. Business-centric Evaluation
   - 3.1 Cost Function and Optimal Point Estimators
   - 3.2 Evaluation Using KPIs
   - 3.3 A/B Test

4. Monitoring
   - 4.1 Visual Monitoring Using Dashboards
   - 4.2 Automated Reporting and Alerting

5. Avoiding Common Fallacies
   - 5.1 Cognitive Biases
   - 5.2 Statistical Effects
   - 5.3 Change Management: Transformation to a Data-driven Company

Literature

Compulsory Reading

Further Reading

- Few, S. (2013). Information dashboard design: Displaying data for at-a-glance monitoring (2nd ed.). Burlingame, CA: Analytics Press.
- Gilliland, M., Tashman, L., & Sglavo, U. (2016). Business forecasting: Practical problems and solutions. Hoboken, NJ: John Wiley & Sons.
- Hyndman, R. (2018). Forecasting: Principles and practices (2nd ed.). Melbourne: OTexts.
- Kahneman, D. (2012). Thinking, fast and slow. New York, NY: Penguin Books.
- Osterwalder, A., & Pigneur, Y. (2010). Business model generation. Hoboken, NJ: Wiley.
- Parmenter, D. (2015). Key performance indicators: Developing, implementing, and using winning KPIs. Hoboken, NJ: John Wiley & Sons.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Seminar: AI and Society

Module Code: DLMAISAIS

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. Tim Schlippe (Seminar: AI and Society)

Contributing Courses to Module

- Seminar: AI and Society (DLMAISAIS01)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents

In this module, students will reflect on current societal and political implications of artificial intelligence. To this end, pertinent topics will be introduced via articles that are then critically evaluated by the students in the form of a written essay.

Learning Outcomes

Seminar: AI and Society

On successful completion, students will be able to

- name selected current societal topics and issues in artificial intelligence.
- explain the influence and impact of artificial intelligence on societal, economic, and polital topics.
- transfer theoretically-acquired knowledge to real-world cases.
- treat in a scientific manner a select topic in the form of a written essay.
- critically question and discuss current societal and political issues arising from the recent advances in artificial intelligence methodology.
- develop own problem-solving skills and processes through reflection on the possible impact of their future occupation in the sector of artificial intelligence.

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 Programmes in the IT & Technology fields

Seminar: AI and Society

Course Code: DLMAISAIS01

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

Course Description

In the current decade, impressive advances have been achieved in the field of artificial intelligence. Several cognitive tasks like object recognition in images and video, natural language processing, game strategy, and autonomous driving and robotics are now being performed by machines at unprecedented levels of ability. This course will examine some of societal, economic, and political implications of these developments.

Course Outcomes

On successful completion, students will be able to

- name selected current societal topics and issues in artificial intelligence.
- explain the influence and impact of artificial intelligence on societal, economic, and polital topics.
- transfer theoretically-acquired knowledge to real-world cases.
- treat in a scientific manner a select topic in the form of a written essay.
- critically question and discuss current societal and political issues arising from the recent advances in artificial intelligence methodology.
- develop own problem-solving skills and processes through reflection on the possible impact of their future occupation in the sector of artificial intelligence.

Contents

- The seminar covers current topics concerning the societal impact of artificial intelligence. Each participant must create a seminar paper on a topic assigned to him/her. A current list of topics is given in the Learning Management System.

Literature
Compulsory Reading
Further Reading ' Turabian, K. L. (2013). A manual for writers of research papers, theses, and dissertations. Chicago: University of Chicago Press. ' Swales, J. M., & Feak, C. R. (2012). Academic writing for graduate students, essential tasks and skills. Michigan: University of Michigan Press. ' Bailey, S. (2011). Academic writing for international students of business. New York, NY: Routledge

Study Format myStudies

Study Format	Course Type
myStudies	Seminar

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Advanced Statistics

Module Code: DLMDSAS

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. Paul Libbrecht (Advanced Statistics)

Contributing Courses to Module

- Advanced Statistics (DLMDSAS01)

Module Exam Type

Module Exam	Split Exam
Study Format: myStudies Advanced Workbook Study Format: Distance Learning Advanced Workbook	

Weight of Module

see curriculum

Module Contents

- Introduction to statistics
- Important probability distributions and their applications
- Bayesian statistics
- Descriptive statistics
- Data visualization
- Parameter estimation
- Hypothesis tests

Learning Outcomes

Advanced Statistics

On successful completion, students will be able to

- understand the fundamental building blocks of statistics.
- analyze stochastic data in terms of the underlying probability distributions.
- utilize Bayesian statistics techniques.
- summarize the properties of observed data using descriptive statistics.
- apply data visualization techniques to design graphics that illustrate the behavior of observed data.
- evaluate model parameters using parameter estimation techniques.
- create hypothesis tests to discriminate between several model classes.

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 Programmes in the Business & Management field.

Advanced Statistics

Course Code: DLMDSAS01

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

Course Description

Nearly all processes in nature and technical or scientific scenarios are not deterministic but stochastic. Therefore, these processes must be described in terms of probabilities and probability density distributions.After defining and introducing the fundamental concepts of statistics, the course will cover important probability distributions and their prevalence in application scenarios; discuss descriptive techniques to summarize and visualize data effectively; and discuss the Bayesian approach to statistics.Estimating parameters is a key ingredient in optimizing data models, and the course will give a thorough overview of the most important techniques.Hypothesis testing is a crucial aspect in establishing the observation of new effects and determination of the significance of statistical effects. Special focus will be given to the correct interpretation of p-Values and the correct procedure for multiple hypothesis tests.

Course Outcomes

On successful completion, students will be able to

- understand the fundamental building blocks of statistics.
- analyze stochastic data in terms of the underlying probability distributions.
- utilize Bayesian statistics techniques.
- summarize the properties of observed data using descriptive statistics.
- apply data visualization techniques to design graphics that illustrate the behavior of observed data.
- evaluate model parameters using parameter estimation techniques.
- create hypothesis tests to discriminate between several model classes.

Contents

1. Introduction to Statistics
   - 1.1 Random Variables
   - 1.2 Kolmogorov Axioms
   - 1.3 Probability Distributions
   - 1.4 Decomposing probability distributions
   - 1.5 Expectation Values and Moments
   - 1.6 Central Limit Theorem
   - 1.7 Sufficient Statistics
   - 1.8 Problems of Dimensionality
   - 1.9 Component Analysis and Discriminants

2. Important Probability Distributions and their Applications
   - 2.1 Binomial Distribution
   - 2.2 Gauss or Normal Distribution
   - 2.3 Poisson and Gamma-Poisson Distribution
   - 2.4 Weibull Distribution

3. Bayesian Statistics
   - 3.1 Bayes' Rule
   - 3.2 Estimating the Prior, Benford's Law, Jeffry's Rule
   - 3.3 Conjugate Prior
   - 3.4 Bayesian & Frequentist Approach

4. Descriptive Statistics
   - 4.1 Mean, Median, Mode, Quantiles
   - 4.2 Variance, Skewness, Kurtosis

5. Data Visualization
   - 5.1 General Principles of Dataviz/Visual Communication
   - 5.2 1D, 2D Histograms
   - 5.3 Box Plot, Violin Plot
   - 5.4 Scatter Plot, Scatter Plot Matrix, Profile Plot
   - 5.5 Bar Chart

6. Parameter Estimation
   - 6.1 Maximum Likelihood
   - 6.2 Ordinary Least Squares
   - 6.3 Expectation Maximization (EM)
   - 6.4 Lasso and Ridge Regularization
   - 6.5 Propagation of Uncertainties

7. Hypothesis Test
   - 7.1 Error of 1st and 2nd Kind
   - 7.2 Multiple Hypothesis Tests
   - 7.3 p-Value

Literature

Compulsory Reading

Further Reading

- Bishop, C. (2007). Pattern recognition and machine learning (2nd ed.). Singapore: Springer.
- Bruce, P., & Bruce, A. (2017). Statistics for data scientists: 50 essential concepts. Sebastopol, CA: O'Reilley Publishing.
- Downey, A. (2013). Think Bayes. Sebastopol, CA: O'Reilley Publishing.
- Downey, A. (2014). Think stats. Sebastopol, CA: O'Reilley Publishing.
- McKay, D. (2003). Information theory, inference and learning algorithms. Cambridge: Cambridge University Press.
- Reinhart, A. (2015). Statistics done wrong. San Francisco, CA: No Starch Press.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Advanced Workbook

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Advanced Workbook

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Project: AI Use Case

Module Code: DLMAIPAIUC

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSAM, DLMDSUCE	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. Tim Schlippe (Project: AI Use Case)

Contributing Courses to Module

- Project: AI Use Case (DLMAIPAIUC01)

Module Exam Type

Module Exam	Split Exam
Study Format: myStudies Portfolio Study Format: Distance Learning Portfolio	

Weight of Module

see curriculum

Module Contents

A current list of topics is given in the Learning Management System. This forms the basis of the course but can be amended or updated by the tutor.

Learning Outcomes

Project: AI Use Case

On successful completion, students will be able to

- apply the concepts covered in the preceding artificial intelligence (AI) courses to build a running AI model or system.
- explain the design choices made in the selection of the employed model and its implementation.
- transfer acquired theoretical knowledge to real-world case studies.
- translate the learned theories into the practice of AI system building.
- critically evaluate the resulting model's or system's 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 fields of Data Science & Artificial Intelligence	All Master Programmes in the IT & Technology fields

Project: AI Use Case

Course Code: DLMAIPAIUC01

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

Course Description

In the course “Project: AI Use Case”, students choose a project task in accord with their tutor from a variety of options. The goal is to prototypically implement an artificial intelligence model or system in a suitable development environment. The choice of approach, the system or software implemented, and the resulting performance on the task are to be reasoned about, explained, and documented in a project report. To this end, students make practical use of the methodological knowledge acquired in the previous courses by applying them to relevant real-world problems.

Course Outcomes

On successful completion, students will be able to

- apply the concepts covered in the preceding artificial intelligence (AI) courses to build a running AI model or system.
- explain the design choices made in the selection of the employed model and its implementation.
- transfer acquired theoretical knowledge to real-world case studies.
- translate the learned theories into the practice of AI system building.
- critically evaluate the resulting model’s or system’s performance.

Contents

- In this project course the students work on a practical implementation of an artificial intelligence use case of their choosing. All relevant artifacts like use case evaluation, chosen implementation method, code, and outcomes are to be documented in the form of a written project report.

Literature
Compulsory Reading
Further Reading ' Jackson, P. (1998). Introduction to expert systems (3rd. ed.). Chicago, IL: Addison Wesley Longman. ' Nilsson, N. (2009). The quest for artificial intelligence. Cambridge: Cambridge University Press. ' Russel, S., & Norvig, P. (2009). Artificial intelligence: A modern approach (3rd ed.). Malaysia: Pearson.

Study Format myStudies

Study Format	Course Type
myStudies	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

2. Semester

Programming with Python

Module Code: DLMDSPWP

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

Dr. Cosmina Croitoru (Programming with Python)

Contributing Courses to Module

- Programming with Python (DLMDSPWP01)

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 the Python programming language
- Object-oriented concepts in Python
- Handling of exceptions and errors
- The Python library ecosystem
- Environments and package management
- Documentation and testing
- Version control

Learning Outcomes

Programming with Python

On successful completion, students will be able to

- remember basic Python syntax and programming concepts.
- understand object-oriented concepts in Python.
- analyze and apply different methods for error handling in Python.
- know common and important Python libraries and how to apply them to given programming tasks.
- understand concepts like environments and version control.

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 Programmes in the IT & Technology field.

Programming with Python

Course Code: DLMDSPWP01

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

Course Description

Python is one of the most versatile and widely used scripting languages. Its clean and uncluttered syntax as well as its straightforward design greatly contribute to this success and make it an ideal language for programming education. Its application ranges from web development to scientific computing. Especially in the fields of data science and artificial intelligence, it is the most common programming language supported by all major data-handling and analytical frameworks. This course provides a thorough introduction to the language and its main features, as well as insights into the rationale and application of important adjacent concepts such as environments, testing, and version control.

Course Outcomes

On successful completion, students will be able to

- remember basic Python syntax and programming concepts.
- understand object-oriented concepts in Python.
- analyze and apply different methods for error handling in Python.
- know common and important Python libraries and how to apply them to given programming tasks.
- understand concepts like environments and version control.

Contents

1. Introduction to Python
   - 1.1 Data structures
   - 1.2 Functions
   - 1.3 Flow control
   - 1.4 Input / Output
   - 1.5 Modules & packages
2. Classes and inheritance
   - 2.1 Scopes and namespaces
   - 2.2 Classes and inheritance
   - 2.3 Iterators and generators

3. Errors and exceptions
   - 3.1 Syntax errors
   - 3.2 Handling and raising exceptions
   - 3.3 User-defined exceptions

4. Important libraries
   - 4.1 Standard Python library
   - 4.2 Scientific calculations
   - 4.3 Speeding up Python
   - 4.4 Visualization
   - 4.5 Accessing databases

5. Working with Python
   - 5.1 Virtual environments
   - 5.2 Managing packages
   - 5.3 Unit and integration testing
   - 5.4 Documenting code

6. Version control
   - 6.1 Introduction to version control
   - 6.2 Version control with GIT

Literature

Compulsory Reading

Further Reading

- Lutz, M. (2017). Learning python (5th ed.). O'Reilly.
- Mathes, E. (2019). Python crash course. (2nd ed.). No Starch Press.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

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. Thomas Zöller (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 Programmes in the IT & Technology fields

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	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ 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. Thomas Zöller (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 earning
- 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 Programmes in the IT & Technology fields

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. (2017). Deep learning with Python. Shelter Island, NY: Manning.
- Efron, B., & Hastie, T. (2016). Computer age statistical inference. Cambridge: Cambridge University Press.
- Geron, A. (2017). Hands-on machine learning with Scikit-Learn and TensorFlow. Boston, MA: O'Reilly Publishing.
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. Boston, MA: MIT Press.
- Russel, S., & Norvig, P. (2010). Artificial intelligence – A modern approach (3rd ed.). Essex: Pearson.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

NLP and Computer Vision

Module Code: DLMAINLPCV

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSAM, DLMDSPWP, DLMDSML	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

N.N Professur für Computer Vision (NLP and Computer Vision)

Contributing Courses to Module

- NLP and Computer Vision (DLMAINLPCV01)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents

- Important methods in computer vision and NLP
- Relevant applications in both domains
- Security and privacy implications of computer vision and NLP

Learning Outcomes

NLP and Computer Vision

On successful completion, students will be able to

- name important problems in natural language and image processing.
- recognize the common algorithms and methods to address said problems.
- understand common use-case scenarios in which NLP and computer vision techniques are applied.
- analyze the advantages and drawbacks of various NLP and computer vision algorithms.
- reflect on pertinent implications of NLP and computer vision technology with respect to privacy and security.

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 Programmes in the IT & Technology fields

NLP and Computer Vision

Course Code: DLMAINLPCV01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSAM, DLMDSPWP, DLMDSML

Course Description

This course elucidates contemporary approaches to computer vision and natural language processing. In order to achieve this goal, two problem domains are introduced with a comprehensive overview on related topics and techniques. It is then demonstrated how related tasks arise in relevant application scenarios. Finally, an outlook on privacy and security aspects is provided in order to sensitize the students to pressing questions in this domain.

Course Outcomes

On successful completion, students will be able to

- name important problems in natural language and image processing.
- recognize the common algorithms and methods to address said problems.
- understand common use-case scenarios in which NLP and computer vision techniques are applied.
- analyze the advantages and drawbacks of various NLP and computer vision algorithms.
- reflect on pertinent implications of NLP and computer vision technology with respect to privacy and security.

Contents

1. Introduction to NLP
   - 1.1 What is NLP?
   - 1.2 Regular expressions, tokenization & stop-words
   - 1.3 Bag of Words and word vectors
   - 1.4 N-Grams: Grouping related words
   - 1.5 Word sense disambiguation
   - 1.6 NLP with Python
2. Applications of NLP
   - 2.1 Topic identification and text summary
   - 2.2 Sentiment analysis
   - 2.3 Named entity recognition
   - 2.4 Translation
   - 2.5 Chatbots

3. Introduction to Computer Vision
   - 3.1 What is computer vision?
   - 3.2 Pixels and filters
   - 3.3 Feature detection
   - 3.4 Distortion and calibration
   - 3.5 Multiple & stereo vision
   - 3.6 Computer vision with Python

4. Applications of Computer Vision
   - 4.1 Image classification, motion tracking
   - 4.2 Semantic segmentation
   - 4.3 Object identification & tracking
   - 4.4 Eigenfaces and facial recognition

5. Privacy and Security
   - 5.1 Adversarial image attacks
   - 5.2 Privacy of visual data & privacy preserving visual features
   - 5.3 Wearable and mobile camera privacy

Literature

Compulsory Reading

Further Reading

- Bird S., Klein, E., & Loper, E. (2009). Natural language processing with Python. O'Reilly.
- Fisher, R. B., Breckon, T. P., Dawson-Howe, K., Fitzgibbon, A. , Robertson, C. , Trucco, E., & Williams, C. K. I. (2014). Dictionary of computer vision and image processing. Wiley .

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Inference and Causality

Module Code: DLMAIIAC

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSAM, DLMDSAS, DLMDSPWP	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. Ulrich Kerzel (Inference and Causality)

Contributing Courses to Module

- Inference and Causality (DLMAIIAC01)

Module Exam Type

Module Exam	Split Exam
Study Format: myStudies Advanced Workbook Study Format: Distance Learning Advanced Workbook	

Weight of Module

see curriculum

Module Contents

- Statistical inference
- Introduction to causality
- Interventions
- Do-calculus
- Fallacies

Learning Outcomes

Inference and Causality

On successful completion, students will be able to

- examine data in terms of statistical inference.
- create probabilistic models.
- understand the building blocks of causal inference.
- analyze interventions in statistical systems.
- follow the rules of do-calculus.
- evaluate common fallacies in causal analysis.

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 Programmes in the IT & Technology fields

Inference and Causality

Course Code: DLMAIIAC01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSAM, DLMDSAS, DLMDSPWP

Course Description

Statistical inference and causal analysis are crucial tools for analyzing and understanding data on a fundamental level. This course starts with an introduction to Bayesian inference and Bayesian networks which use probabilities to describe statistical problems and introduce probabilistic modelling which allows the specification of Bayesian statistical models in code. This course introduces the concepts of causality, how causality relates to correlation between variables, and discusses the fundamental building blocks of causal analysis. The effect of interventions (i.e., when the experimenter actively changes the setup from which the data are taken) are also discussed. This course then introduces the rules of do-calculus, which allow interventions to be described formally.Finally, the course discusses a wide range of typical fallacies which arise in the context of causal analysis.

Course Outcomes

On successful completion, students will be able to

- examine data in terms of statistical inference.
- create probabilistic models.
- understand the building blocks of causal inference.
- analyze interventions in statistical systems.
- follow the rules of do-calculus.
- evaluate common fallacies in causal analysis.

Contents

1. Statistical Inference
   - 1.1 Bayesian inference
   - 1.2 Bayesian networks
   - 1.3 Probabilistic modelling
2. Introduction to Causality
   - 2.1 Correlation vs causation
   - 2.2 Granger causality
   - 2.3 Directed Acyclic Graphs (DAG)
   - 2.4 Elements of causal graphs: collider, chain, fork
   - 2.5 D – separation

3. Interventions
   - 3.1 Seeing vs doing
   - 3.2 Conditional independence
   - 3.3 Confounders & counterfactuals
   - 3.4 Causal inference vs randomized controlled trials

4. Do-calculus
   - 4.1 Front- & backdoor criterion
   - 4.2 Three rules of do-calculus

5. Fallacies
   - 5.1 Mediation fallacy
   - 5.2 Collider bias
   - 5.3 Simpson's & Berkson's Paradox
   - 5.4 Imputing missing values: causal vs data-driven view

Literature

Compulsory Reading

Further Reading

- Berzuini, C., Dawid, P., & Bernardinelli, L. (2012). Causality: Statistical perspectives and applications. Wiley.
- Hernan, M. A., & Robins, J. M. (2020). Causal inference: What if. CRC Press.
- Pearl, J. (2013). Causality: Models, reasoning and inference (2nd ed.). Cambridge University Press.
- Pearl, J., & Mackenzie, D. (2018). The book of why: The new science of cause and effect. Basic Books.
- Pearl, J., Glymour, M., & Jewell, N. P. (2016). Causal inference in statistics: A primer. Wiley.
- Wakefield, J. (2013). Bayesian and frequentist regression methods. Springer.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Advanced Workbook

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Advanced Workbook

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Reinforcement Learning

Module Code: DLMAIRIL

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSAM, DLMDSPWP, DLMDSML, DLMDSDL	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. Ulrich Kerzel (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 Programmes in the IT & Technology fields

Reinforcement Learning

Course Code: DLMAIRIL01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSAM, DLMDSPWP, DLMDSML, DLMDSDL

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	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

3. Semester

Software Engineering for Data Intensive Sciences

Module Code: DLMDSSEDIS

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	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. Max Pumperla (Software Engineering for Data Intensive Sciences)

Contributing Courses to Module

- Software Engineering for Data Intensive Sciences (DLMDSSEDIS01)

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

- Agile project management
- DevOps
- Software development
- API
- From model to production

Learning Outcomes

Software Engineering for Data Intensive Sciences

On successful completion, students will be able to

- understand the agile approaches Scrum and Kanban.
- explain how DevOps brings software development and operations together into one team.
- write high-quality code using relevant software development techniques.
- evaluate the requirements for APIs.
- create APIs for software applications.
- identify the challenges of bringing a model into production.

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 Programmes in the IT & Technology fields

Software Engineering for Data Intensive Sciences

Course Code: DLMDSSEDIS01

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

Course Description

Building a successful data-based product requires a significant amount of high-quality code which needs to run in a professional production environment. This course starts by introducing the agile approaches Scrum and Kanban and then discusses the shift from more traditional software development approaches to the DevOps culture.Special focus is given to the discussion and understanding of techniques and approaches for producing high-quality code such as unit and integration testing, test-driven development, pair programing, and continuous delivery and integration.Since many software artefacts are accessed via APIs, this course introduces concepts of API design and paradigms.Finally, this course addresses the challenges of bringing code into a production environment, building a scalable environment, and using cloud-cased approaches.

Course Outcomes

On successful completion, students will be able to

- understand the agile approaches Scrum and Kanban.
- explain how DevOps brings software development and operations together into one team.
- write high-quality code using relevant software development techniques.
- evaluate the requirements for APIs.
- create APIs for software applications.
- identify the challenges of bringing a model into production.

Contents

1. Agile Project Management
   - 1.1 Introduction to SCRUM
   - 1.2 Introduction to Kanban
2. DevOps
   - 2.1 Traditional lifecycle management
   - 2.2 Bringing development and operations together
   - 2.3 Impact of team structure
   - 2.4 Building a DevOps infrastructure

3. Software Development
   - 3.1 Unit & integration test, performance monitoring
   - 3.2 Test-driven development & pair programing
   - 3.3 Continuous delivery & integration
   - 3.4 Overview of relevant tools

4. API
   - 4.1 API design
   - 4.2 API paradigms

5. From Model to Production
   - 5.1 Building a scalable environment
   - 5.2 Model versioning and persistence
   - 5.3 Cloud-based approaches

Literature

Compulsory Reading

Further Reading

- Farcic, V. (2016). The DevOps 2.0 toolkit: Automating the continuous deployment pipeline with containerized microservices. CreateSpace Independent Publishing Platform.
- Hunt, A., & Thomas, D. (1999). The pragmatic programmer: From journeyman to master. Addison Wesley.
- Kelleher, A. & Kelleher, A. (2019). Machine learning in production: Developing and optimizing data science workflows and applications. Addison-Wesley.
- Kerzner, H. (2017). Project Management - A Systems Approach to Planning, Scheduling, and Controlling (12th ed., pp. 74—75). John Wiley & Sons.
- Martin, R. C. (2008). Clean code. Prentice Hall.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Seminar: Current Topics in AI

Module Code: DLMAISCTAI

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. Tim Schlippe (Seminar: Current Topics in AI)

Contributing Courses to Module

- Seminar: Current Topics in AI (DLMAISCTAI01)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents

In this module, students will reflect on current developments in AI. To this end, pertinent topics will be introduced via articles that are then critically evaluated by the students in the form of a written essay.

Learning Outcomes

Seminar: Current Topics in AI

On successful completion, students will be able to

- discuss current research trends and topics in AI.
- compose a theoretical essay exploring a selected topic in AI.
- expound upon apposite assumptions and design choices pertaining to the topic of choice.
- link the chosen topic to analogous approaches.
- identify and delineate potential uses for the chosen topic's concepts.

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 Programmes in the IT & Technology fields

Seminar: Current Topics in AI

Course Code: DLMAISCTAI01

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

Course Description

The topic of artificial Intelligence (AI) has been addressed in computer science and cognitive science research since the 1950s; however, the meaning associated with the term has changed considerably over time. Having once been predominantly associated with logical calculus, reasoning, and planning, AI is now primarily interpreted in the context of deep networks of computational units. Despite these changes in approach, the important characteristic of AI continues to be the understanding and reproduction of cognitive abilities and functions by machines. This seminar strives to elucidate current research trends in AI. The students learn to independently analyze selected topics and case studies and link them with well-known concepts, as well as critically question and discuss them.

Course Outcomes

On successful completion, students will be able to

- discuss current research trends and topics in AI.
- compose a theoretical essay exploring a selected topic in AI.
- expound upon apposite assumptions and design choices pertaining to the topic of choice.
- link the chosen topic to analogous approaches.
- identify and delineate potential uses for the chosen topic's concepts.

Contents

- The seminar covers current topics in artificial intelligence. Each participant must write a seminar paper on a topic assigned to him/her.

Literature

Compulsory Reading

Further Reading

- Turabian, K. L. (2013). A manual for writers of research papers, theses, and dissertations. Chicago: University of Chicago Press.
- Swales, J. M., & Feak, C. R. (2012). Academic writing for graduate students, essential tasks and skills. Michigan: University of Michigan Press.
- Bailey, S. (2011). Academic writing for international students of business. New York, NY: Routledge

Study Format myStudies

Study Format	Course Type
myStudies	Seminar

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

UI/UX Expert

Module Code: DLMAIEUIUX

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMAIEUIUX01 ' none	MA	10	300 h

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

Module Coordinator

Prof. Dr. Adelka Niels (User Interface and Experience) / Prof. Dr. Adelka Niels (Project: Human Computer Interaction)

Contributing Courses to Module

' User Interface and Experience (DLMAIEUIUX01)
' Project: Human Computer Interaction (DLMAIEUIUX02)

Module Exam Type

Module Exam	Split Exam
	User Interface and Experience • Study Format "Distance Learning": Exam, 90 Minutes Project: Human Computer Interaction • Study Format "Distance Learning": Portfolio

Weight of Module

see curriculum

Module Contents

User Interface and Experience

- ROI of UX design
- Role and mindset of UX design in IT projects
- The UX design process
- UX psychology: How the human mind works
- User research
- UX design basics

Project: Human Computer Interaction

In this course the students will gain practical experience in user experience design. They will conduct user testing for a given user interface and work on developing improvements. The work process and the results will become part of a portfolio.

Learning Outcomes

User Interface and Experience

On successful completion, students will be able to

- Understand what design is about and the crucial aspects of good design
- understand and define the role of the UI/UX designer within a project.
- explain the UX design process and the user-centered mindset.
- advocate the importance of UX design for IT projects.
- describe the basic methods of user research, user testing, and user-centered design.

Project: Human Computer Interaction

On successful completion, students will be able to

- evaluate the usability of a user interface.
- conduct user testing.
- understand the practical implications of putting users first.
- make small changes in existing user interfaces and recognize the situations in which a user experience designer should be consulted.

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 fields

User Interface and Experience

Course Code: DLMAIEUIUX01

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

Course Description

UX design is crucial to the development of new IT services and applications and enhances the quality of the outcome. Applying UX design techniques can significantly and positively change the software development process, and good UX design is the result of effective teamwork. Within this course the students will understand the mindset, basic techniques, and impact of UX design on IT projects. They will learn how the UX design process works and the role of the UX designer within IT projects. They will also gain skills in the type of collaboration that produces the best results. Using their basic knowledge about good design, the students will know when it is appropriate that they make small changes to UIs themselves and when it is time to consult a designer.

Course Outcomes

On successful completion, students will be able to

- Understand what design is about and the crucial aspects of good design
- understand and define the role of the UI/UX designer within a project.
- explain the UX design process and the user-centered mindset.
- advocate the importance of UX design for IT projects.
- describe the basic methods of user research, user testing, and user-centered design.

Contents

1. ROI of UX design
   - 1.1 Efficacy
   - 1.2 Efficiency
   - 1.3 The impact of design on use errors
2. Role and Mindset of UX design in IT projects
   - 2.1 The role of UX design: the UX designer
   - 2.2 The UX mindset: putting the user first
3. The UX design Process
   - 3.1 In a waterfall process environment
   - 3.2 In an agile process environment

4. UX Psychology: How the Human Mind Works
   - 4.1 Perceptual psychology
   - 4.2 Information processing
   - 4.3 Decision-making
   - 4.4 Situation awareness
   - 4.5 Errors

5. User Research
   - 5.1 The benefit of user research
   - 5.2 Basic research techniques
   - 5.3 User testing

6. UX design Basics
   - 6.1 Interaction design
   - 6.2 Information architecture
   - 6.3 Screen design
   - 6.4 Graphic design
   - 6.5 Rules of good design

Literature

Compulsory Reading

Further Reading

- Cooper, A., Reimann, R., Cronin, D., & Noessel, C. (2014). About face: The essentials of interaction design (5th ed.). Wiley.
- Johnson, J. (2010). Designing with the mind in mind. Elsevier.
- Preece, J., Sharp, H., & Rogers, Y. (2015). Interaction design: Beyond human-computer interaction (5th ed.). Wiley.
- Unger, R., & Chandler, C. (2012). A project guide to UX design: For user experience designers in the field or in the making. New Riders Pub.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Project: Human Computer Interaction

Course Code: DLMAIEUIUX02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMAIEUIUX01

Course Description

In this course the students will gain practical experience in user experience design. They will set up and conduct a user testing for a given user interface and develop improvements. The work process and the results will become part of a portfolio.

Course Outcomes

On successful completion, students will be able to

- evaluate the usability of a user interface.
- conduct user testing.
- understand the practical implications of putting users first.
- make small changes in existing user interfaces and recognize the situations in which a user experience designer should be consulted.

Contents

- User experience design focusses on the needs of users. Within this portfolio project the students put into practice basic techniques which lead to good user-centered design. They learn how to test the user experience and usability of an application by conducting user tests, and they also learn how to develop and test ideas for improvement. Students will finish this course having gained practical experience working within the mindset of putting users first.

Literature

Compulsory Reading

Further Reading

- Barnum, C. (2010): Usability Testing Essentials: Ready, Set...Test!, Morgan Kaufmann, Burlington, USA
- Cooper, A., Reimann, R., Cronin, D., & Noessel, C. (2014). About face: The essentials of interaction design. New York, NY: Wiley.
- Johnson, J. (2010). Designing with the mind in mind. Burlington, MA: Elsevier.
- Preece, J., Sharp, H., & Rogers, Y. (2015). Interaction design: Beyond human-computer interaction. New York, NY: Wiley.
- Microsoft Windows Dev Center. (2018). Guidelines. [Web page]. Retrieved from https://docs.microsoft.com/en-us/windows/desktop/uxguide/guidelines
- Unger, R., & Chandler, C. (2012). A project guide to UX design. Berkeley, CA: New Riders.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Technical Project Lead

Module Code: DLMDSETPL

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	None	MA	10	300 h

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

Module Coordinator

Prof. Dr. Carsten Skerra (IT Project Management) / Prof. Dr. Dorian Mora (Project: Technical Project Planning)

Contributing Courses to Module

- IT Project Management (DLMBITPAM01)
- Project: Technical Project Planning (DLMDSETPL01)

Module Exam Type

Module Exam	Split Exam
	IT Project Management • Study Format "Distance Learning": Exam, 90 Minutes Project: Technical Project Planning • Study Format "Distance Learning": Portfolio

Weight of Module

see curriculum

Module Contents

IT Project Management

- Organizing the work
- Cost estimation and controlling
- The human factor
- Organizing small, medium, and large projects

Project: Technical Project Planning

In this course, students learn to apply the project management concepts they learned in previous modules in a real-world project.

Learning Outcomes

IT Project Management

On successful completion, students will be able to

- critically reflect the status of knowledge on IT project management.
- set up different IT project management formats (small, medium and large projects) and know the methods for managing these different IT projects professionally.
- develop an IT management proposal as the fundament of a professional IT project management concept.
- understand and integrate different IT management project plans (e.g., time plan, cost plan, resources plan, risk plan) and use those plans in an integrative IT project planning and controlling scheme.
- organize and to lead an IT project team and its core and/or extended team members.

Project: Technical Project Planning

On successful completion, students will be able to

- apply the concepts of project management to real-world tasks and problems.
- translate the learned theories into the practice of project management.
- analyze a real-world problem and define and implement a project to resolve it.
- appraise the results of a project performed and identify what worked well and what did not.
- explain the work they perform, give its scientific background, and produce adequate documentation.

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 Computer Science & Software Development and Data Science & Artificial Intelligence.	All Master Programmes in the IT & Technology field.

IT Project Management

Course Code: DLMBITPAM01

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

Course Description

The purpose of this course is to introduce students to the concepts involved in IT project management. This is achieved through the development of an understanding of the fundamental tenets of project management enhancing the students' ability to apply their knowledge, skills and competencies in analyzing and solving IT project management problems. A special focus is put on the specifics of IT project organization, cost management and the human factor within IT projects.

Course Outcomes

On successful completion, students will be able to

- critically reflect the status of knowledge on IT project management.
- set up different IT project management formats (small, medium and large projects) and know the methods for managing these different IT projects professionally.
- develop an IT management proposal as the fundament of a professional IT project management concept.
- understand and integrate different IT management project plans (e.g., time plan, cost plan, resources plan, risk plan) and use those plans in an integrative IT project planning and controlling scheme.
- organize and to lead an IT project team and its core and/or extended team members.

Contents

1. Introduction: Characteristics of IT Projects
   - 1.1 Defining IT Projects
   - 1.2 Overview on Typical Roles and Phases of IT Projects
   - 1.3 Risks and Challenges of IT Projects
   - 1.4 Role of an IT Project Manager
2. Organizing the Work
   - 2.1 Project Breakdown Structure, Work Packages
   - 2.2 Prioritization
   - 2.3 Time Planning, Milestones, Gantt-Diagram
   - 2.4 Definition of Done

3. Cost Estimation and Controlling
   - 3.1 Challenges of Cost Estimation in IT Projects
   - 3.2 Estimation Techniques: 3-Point Estimation, Double Blind Expert Estimation, Function Points
   - 3.3 Cost Controlling Using Earned Value Analysis
   - 3.4 Risk Management

4. The Human Factor
   - 4.1 Vision Keeping
   - 4.2 Stakeholder Management
   - 4.3 Conflict Management

5. Organizing Small and Medium Projects
   - 5.1 Rational Unified Process (RUP)
   - 5.2 Agile Software Processes
   - 5.3 Scrum
   - 5.4 Plan-driven Project Management in Small Projects

6. Organizing Large Projects
   - 6.1 PMBOK Guide
   - 6.2 Prince2
   - 6.3 Multi Project Management
   - 6.4 Agile Software Processes in Large Projects
   - 6.5 Selection of the Appropriate Project Management Method

Literature

Compulsory Reading

Further Reading

- Stephens, R. (2015). Beginning software engineering. Chichester: John Wiley & Sons. (Database: ProQuest).
- Hans, R. T. (2013). Work breakdown structure: A tool for software project scope verification. Pretoria: Tshwane University of Technology.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Project: Technical Project Planning

Course Code: DLMDSETPL01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMBITPAM01

Course Description

The focus of this course is to apply the project management knowledge gained previously in a practical portfolio project and reflect on the results. Students engage in this portfolio project and document the results, reflecting on the project management concepts they apply and the influence of these concepts on the success of the project.

Course Outcomes

On successful completion, students will be able to

- apply the concepts of project management to real-world tasks and problems.
- translate the learned theories into the practice of project management.
- analyze a real-world problem and define and implement a project to resolve it.
- appraise the results of a project performed and identify what worked well and what did not.
- explain the work they perform, give its scientific background, and produce adequate documentation.

Contents

- In this course, students perform and document a portfolio project in which they apply the project management topics covered in previous modules.

Literature

Compulsory Reading

Further Reading

- Hinde, D. (2012). PRINCE2 Study Guide. West Sussex: John Wiley & Sons.
- Kneuper, R. (2018). Software processes and lifecycle models. Cham: Springer Nature Switzerland.
- Phillips, J. (2010). IT project management: On track from start to finish (3rd ed.). New York, NY: McGraw-Hill.
- Project Management Institute. (2013). A guide to the project management body of knowledge: PMBOK guide.
- Schwaber, K. (2004). Agile project management with Scrum. Redmond, WA: Microsoft Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

DLMDSETPL01

AI Specialist

Module Code: DLMAIEAIS

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DDLMDSAM, DLMDSPWP, DLMDSML, DLMAINLPCV, DLMAIEAIS01 ' DLMDSAM, DLMDSPWP, DLMDSML, DLMAINLPCV01	MA	10	300 h

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

Module Coordinator

N.N. Professur für Computer Vision (Advanced NLP and Computer Vision) / Prof. Dr. Tim Schlippe (Project: NLP and Computer Vision)

Contributing Courses to Module

- Advanced NLP and Computer Vision (DLMAIEAIS01)
- Project: NLP and Computer Vision (DLMAIEAIS02)

Module Exam Type

Module Exam	Split Exam
	Advanced NLP and Computer Vision • Study Format "Distance Learning": Exam, 90 Minutes Project: NLP and Computer Vision • Study Format "Fernstudium": Portfolio

Weight of Module

see curriculum

Module Contents

Advanced NLP and Computer Vision

- Machine translation and semantic text interpretation
- Recovery of scene geometry
- Semantic image and video analysis
- Object tracking

Project: NLP and Computer Vision

- Transfer and application of methodological computer vision and NLP knowledge
- Implementation of an NLP or computer vision software module

Learning Outcomes

Advanced NLP and Computer Vision

On successful completion, students will be able to

- name core aspects of advanced computer vision and NLP problems and techniques.
- summarize current approaches to problems in text and speech processing.
- recognize promising developments in scene understanding and semantic image analysis.
- remember challenges and solution strategies in single and multiple object tracking.

Project: NLP and Computer Vision

On successful completion, students will be able to

- apply knowledge of NLP and computer vision methods to practical problems.
- evaluate different methods, algorithms, and approaches to solving a given problem with respect to its set of constraints.
- recognize the benefits and drawbacks of design options and choices.
- build real-world computer vision or NLP applications.

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 Programmes in the IT & Technology fields

Advanced NLP and Computer Vision

Course Code: DLMAIEAIS01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSAM, DLMDSPWP, DLMDSML, DLMAINLPCV01

Course Description

This course expands upon the material presented in the introductory NLP and Computer Vision course. With respect to the processing of text, it provides an overview of machine translation and information extraction. Moreover, it addresses signal processing aspects of NLP such as speech recognition and synthesis. Additionally, important concepts from the subject domain of computer vision such as the recovery of scene geometry, the semantic analysis of still and video imagery, and object tracking are discussed.

Course Outcomes

On successful completion, students will be able to

- name core aspects of advanced computer vision and NLP problems and techniques.
- summarize current approaches to problems in text and speech processing.
- recognize promising developments in scene understanding and semantic image analysis.
- remember challenges and solution strategies in single and multiple object tracking.

Contents

1. Text Processing
   - 1.1 Machine translation
   - 1.2 Information extraction
2. Speech Signal Processing
   - 2.1 Speech recognition
   - 2.2 Speech synthesis
3. Geometry Reconstruction
   - 3.1 3D reconstruction from 2D images/videos
   - 3.2 Change of perspective

4. Semantic Image Analysis
   - 4.1 Image retrieval
   - 4.2 Semantic segmentation / object detection
   - 4.3 Medical imaging analysis
   - 4.4 Copyright violation, counterfeit and forgery detection
   - 4.5 Face recognition and biometrics

5. Tracking
   - 5.1 Challenges in tracking
   - 5.2 Object representation
   - 5.3 Single vs. multiple object tracking

Literature

Compulsory Reading

Further Reading

- Bengfort, B., Bilbro, R., & Ojeda, T. (2018). Applied text analysis with Python: Enabling language aware data products with machine learning. O'Reilly.
- Clark, A., Fox, C., & Lappin, S. (Eds.). (2010). The handbook of computational linguistics and natural language processing. Wiley-Blackwell.
- Davies, E. R. (2017). Computer vision: Principles, algorithms, applications, learning (5th ed.). Academic Press.
- Fisher, R. B., Breckon, T. P., Dawson-Howe, K., Fitzgibbon, A., Robertson, C., Trucco, E., & Williams, C. K. I. (2016). Dictionary of computer vision and image processing (2nd ed.). Wiley.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Project: NLP and Computer Vision

Course Code: DLMAIEAIS02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DDLMDSAM, DLMDSPWP, DLMDSML, DLMAINLPCV, DLMAIEAIS01

Course Description

This course is intended to give students an opportunity to apply their knowledge in NLP and computer vision to a real-world implementation task. To this end, an apposite solution for a given task and the accompanying set of constraints must be found. Methodological and algorithmic choices must be appropriately evaluated to find the best path forward. The found solution design is implemented as a running piece of software, furthering the students' programming skills.

Course Outcomes

On successful completion, students will be able to

- apply knowledge of NLP and computer vision methods to practical problems.
- evaluate different methods, algorithms, and approaches to solving a given problem with respect to its set of constraints.
- recognize the benefits and drawbacks of design options and choices.
- build real-world computer vision or NLP applications.

Contents

- In this course, students will put the knowledge acquired in the preceding course, Advanced NLP and Computer Vision, into practice through the implementation of an NLP or computer vision project of their choosing.

Literature
Compulsory Reading
Further Reading ' Bengfort, B., & Ojeda, T. (2018). Applied text analysis with Python: Enabling language aware data products with machine learning. Sebastopol, CA: O'Reilly ' Clark, A., Fox, C., & Lappin, S. (Eds.). (2010). Handbook of computational linguistics and natural language processing. Malden, MA: Wiley-Blackwell. ' Davies, E. R. (2017). Computer vision: Principles, algorithms, applications, learning (5th ed.). Cambridge, MA: Academic Press. ' Fisher, R. B., Breckon, T. P., Dawson-Howe, K., Fitzgibbon, A., Robertson, C., Trucco, E., Williams, C. K. I. (2016). Dictionary of computer vision and image processing. Chichester: John Wiley & Sons Ltd. ' Jurafsky, D., & Martin, J. H. (2008). Speech and language processing. Boston, MA: Prentice Hall. ' Szelski, R. (2011). Computer vision: Algorithms and applications (2nd ed.). Wiesbaden: Springer VS.

Study Format Fernstudium

Study Format	Course Type
Fernstudium	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Data Engineer

Module Code: DLMDSEDE

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	None	MA	10	300 h

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

Module Coordinator

Prof. Dr. Christian Müller-Kett (Data Engineering) / Prof. Dr. Max Pumperla (Project: Data Engineering)

Contributing Courses to Module

- Data Engineering (DLMDSEDE01)
- Project: Data Engineering (DLMDSEDE02)

Module Exam Type

Module Exam	Split Exam
	Data Engineering • Study Format "Distance Learning": Oral Assignment Project: Data Engineering • Study Format "Distance Learning": Portfolio

Weight of Module

see curriculum

Module Contents

Data Engineering

- Principles of data engineering
- Paradigms for data processing at scale
- Overview on data governance, security, and protection
- Common cloud platforms
- DataOps approach

Project: Data Engineering

- Knowledge transfer and application to practical problems
- Implementation of a data infrastructure building block

Learning Outcomes

Data Engineering

On successful completion, students will be able to

- understand the foundational concepts in data engineering.
- categorize important data-processing classes.
- summarize common approaches to data governance and security and contribute to the broader societal discussion on an academic level.
- compare different common public cloud offerings.
- recognize current approaches to data operations (DataOps) including productivity tools to facilitate working in interdisciplinary teams.

Project: Data Engineering

On successful completion, students will be able to

- apply the principles of data engineering to a practical application.
- analyze data engineering approaches with respect to a given project task.
- reason about the benefits and drawbacks of solution alternatives for a given implementation task.
- make apposite architectural choices.
- implement aspects of a modern data pipeline abiding by strict data protection principles.

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 Programmes in the IT & Technology field.

Data Engineering

Course Code: DLMDSEDE01

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

Course Description

The focus of this first course in the Data Engineering elective module is to introduce students to important principles, concepts, methods and approaches in this subject domain. In order to achieve this goal, the course moves from an exposition of the foundational principles of data engineering to a thorough treatment of the core data processing classes. Modern architectural paradigms such as Microservices are explained, and important factors in data governance and protection are addressed. In this context, students are enabled to reflect on modern data protection principles and their societal implications and implement these principles into large-scale data-intensive systems. Aspects of cloud computing are introduced via an overview of the most common offerings on the market. Finally, a state-of-the-art agile perspective on the operation of data pipelines is given by an exposition to the emerging notion of DataOps and the productivity tools around it to facilitate working in interdisciplinary teams.

Course Outcomes

On successful completion, students will be able to

- understand the foundational concepts in data engineering.
- categorize important data-processing classes.
- summarize common approaches to data governance and security and contribute to the broader societal discussion on an academic level.
- compare different common public cloud offerings.
- recognize current approaches to data operations (DataOps) including productivity tools to facilitate working in interdisciplinary teams.

Contents

1. Foundations of Data Systems
   - 1.1 Reliability
   - 1.2 Scalability
   - 1.3 Maintainability
2. Data Processing at Scale
   - 2.1 Batch Processing
   - 2.2 Stream and Complex Event Processing

3. Microservices
   - 3.1 Introduction to Microservices
   - 3.2 Implementing Microservices

4. Governance & Security
   - 4.1 Data Protection
   - 4.2 Data Security
   - 4.3 Data Governance

5. Common Cloud Platforms & Services
   - 5.1 Amazon AWS
   - 5.2 Google Cloud
   - 5.3 Microsoft Azure

6. Data Ops
   - 6.1 Defining Principles
   - 6.2 Containerization
   - 6.3 Building Data Pipelines

Literature

Compulsory Reading

Further Reading

- Andrade, H., Gedik, B., & Turaga, D. (2014). Fundamentals of stream processing: Application design, systems, and analytics. Cambridge University Press.
- Axelrod, C. W. (2013). Engineering safe and secure software systems. Artech House.
- Kleppmann, M. (2017). Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. O'Reilly.
- Newman, S. (2015). Building microservices: Designing fine-grained systems. O'Reilly.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Project: Data Engineering

Course Code: DLMDSEDE02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSEDE01

Course Description

The second course of the Data Engineering elective module builds upon theoretical and methodological insights from the first course. It provides opportunities for students to put their newly-acquired knowledge into practical application by completing a data engineering project.In order to find an appropriate and viable approach, students will have to reason about and evaluate the benefits and drawbacks of possible architectural choices. Once an informed decision has been met, the chosen approach is implemented as a running piece of data infrastructure.

Course Outcomes

On successful completion, students will be able to

- apply the principles of data engineering to a practical application.
- analyze data engineering approaches with respect to a given project task.
- reason about the benefits and drawbacks of solution alternatives for a given implementation task.
- make apposite architectural choices.
- implement aspects of a modern data pipeline abiding by strict data protection principles.

Contents

- The second course of the Data Engineering elective revolves around the implementation of a data engineering project chosen from a set of project suggestions. Students can also contribute their own project ideas.

Literature
Compulsory Reading
Further Reading ' Kleppmann, M. (2017). Designing data intensive applications: The big ideas behind reliable, scalable, and maintainable systems. Sebastopol, CA: O'Reilly. ' Farcic, V. (2016). The DevOps 2.0 toolkit: Automating the continuous deployment pipeline with containerized microservices. Scotts Valley, CA: CreateSpace Independent Publishing Platform. ' White, T. (2015). Hadoop: The definitive guide: Storage and analysis at Internet scale. Sebastopol, CA: O'Reilley. ' Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. (2015). Learning Spark: Lightning fast data analysis. Sebastopol, CA: O'Reilley. ' Narkhede, N., Shapira, G., & Palino, T. (2017). Kafka: The definitive guide: Real-time data and stream processing at scale. Sebastopol, CA: O'Reilley.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Artificial Intelligence in FinTech

Module Code: DLMAIEFT

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIEFT01 ' none	MA	10	300 h

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

Module Coordinator

Prof. Dr. Muhammad Ashfaq (Concepts of FinTechs and Artificial Intelligence) / Prof. Dr. Muhammad Ashfaq (Fraud Detection FinTechs)

Contributing Courses to Module

' Concepts of FinTechs and Artificial Intelligence (DLMAIEFT01)
' Fraud Detection FinTechs (DLMAIEFT02)

Module Exam Type

Module Exam	Split Exam
	Concepts of FinTechs and Artificial Intelligence • Study Format "Distance Learning": Exam or Written Assessment: Written Assignment, 90 Minutes Fraud Detection FinTechs • Study Format "Distance Learning": Written Assessment: Case Study

Weight of Module

see curriculum

Module Contents

Concepts of FinTechs and Artificial Intelligence

- Introduction of FinTechs and AI
- Application of FinTechs in banking and finance
- FinTech and AI underlying Technologies
- AI Application in the financial services industry
- Trust and ethical issues related to AI and FinTech
- Future of FinTech and AI

Fraud Detection FinTechs

- Introduction of Fraud detections FinTechs
- Insurance Fraud
- Money Laundering
- Identity Fraud
- Key application areas of AI Anomaly Detection in financial institutions
- Challenges of AI use in Fraud detection in financial institutions

Learning Outcomes

Concepts of FinTechs and Artificial Intelligence

On successful completion, students will be able to

- understand definitions of FinTech, AI and gain an overview of the FinTech ecosystem and factors of the financial revolution.
- identify different applications of FinTechs in the banking industry such as retail, investment and wealth management.
- learn about key underlying technologies that are shaping the financial revolution by exploring blockchain, Distributed Leader Technology, smart contracts and machine learning.
- learn how AI is supporting financial institutions in areas such as deposits, lending, Know Your Customer (KYC), Anti-Money Laundering (AML) and credit scorecard models.
- critically evaluate different issues related to AI and FinTech such as lack of trust and transparency, data protection and sustainable financing.
- develop a solid understanding of the future of banking, cryptocurrencies and CBDCs.

Fraud Detection FinTechs

On successful completion, students will be able to

- recognize the importance of fraud detection in FinTechs by exploring recent frauds such as Wirecard.
- analyze examples of FinTech and AI companies that are identifying and preventing frauds.
- describe different types of insurance frauds and assess how advanced analytics can help identification of frauds.
- learn how AI can be used in cross-border transactions to detect money laundering and assess the viability of various tools such as machine learning and Regtech.
- critically evaluate how financial institutions are using AI in lending, asset management and protection of personal identity.
- outline challenges of application of AI such as quality of data, shortage of qualified staff, implementation of technology and regulatory issues.

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 Finance & Tax Accounting.	All Master Programs in the Business & Management field.

Concepts of FinTechs and Artificial Intelligence

Course Code: DLMAIEFT01

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

Course Description

There has been an unprecedented level of advancement in technology during the last two decades which impacts all segments of the economy particularly caused a revolution in the financial services industry. Incumbent financial institutions lag in innovative solutions to changing customer needs and are facing a great deal of competition as well as collaboration opportunities from an army of FinTech and AI-based start-ups. In Europe, these start-ups emerged due to open banking regulations and neobanks are challenging established banks' bricks-and-mortar business model. The Covid-19 pandemic has further accelerated the growth of FinTech companies that offer agile, transparent, efficient, cost-effective and innovative solutions to tech-savvy customers in areas such as cross-border payments, online purchases, wealth management and lending – just to mention a few. Thus, FinTechs are transforming financial institutions using technologies such as AI, data analytics and blockchain. Students will have a comprehensive overview of FinTech and AI, learn about the FinTech ecosystem, open banking regulation in Europe, contemporary developments in banking technologies and practical application of FinTech and AI.This course aims to critically discuss the contemporary issues related to FinTech and AI such as regulatory reforms, creativity and innovation challenges, customer data protection, ethical issues and green tech financing. Students will also discuss the future of applications of FinTech and AI in banking and finance and critically evaluate the evolution of cryptocurrencies and central bank digital currencies. This course also provides students an opportunity to debate and discuss how big Tech companies are shaping the finance world, what lessons can be learned from past crises, the future of branch banking, and what impact FinTech and AI starts can make on financing ESG and sustainable projects.

Course Outcomes

On successful completion, students will be able to

- understand definitions of FinTech, AI and gain an overview of the FinTech ecosystem and factors of the financial revolution.
- identify different applications of FinTechs in the banking industry such as retail, investment and wealth management.
- learn about key underlying technologies that are shaping the financial revolution by exploring blockchain, Distributed Leader Technology, smart contracts and machine learning.
- learn how AI is supporting financial institutions in areas such as deposits, lending, Know Your Customer (KYC), Anti-Money Laundering (AML) and credit scorecard models.
- critically evaluate different issues related to AI and FinTech such as lack of trust and transparency, data protection and sustainable financing.
- develop a solid understanding of the future of banking, cryptocurrencies and CBDCs.

Contents

1. Introduction of FinTechs and AI
   - 1.1 Definition of FinTechs and AI
   - 1.2 FinTech Ecosystem
   - 1.3 Revolution in the Financial Services Industry
   - 1.4 Open Banking Regulation
2. Application of FinTechs in Banking and Finance
   - 2.1 Retail Banking
   - 2.2 Payment Transactions
   - 2.3 Wealth Management
   - 2.4 Financing
   - 2.5 Scope of FinTech in Financial Inclusion
3. FinTech and AI Underlying Technologies
   - 3.1 Contemporary Developments in Banking Technology
   - 3.2 Cloud Banking
   - 3.3 Blockchain and DLT and Smart Contracts
   - 3.4 Machine and Deep Learning
   - 3.5 Neuroscience in Finance

4. AI Application in the Financial Services industry
   - 4.1 AI in Deposits and Lending
   - 4.2 Chatbots in Banking
   - 4.3 AI USe in Developing Credit Scoring Models
   - 4.4 AI in the Insurance Sector
   - 4.5 KYC and AML

5. Trust and Ethical Issues Related to AI and FinTech
   - 5.1 Biasness and AI Algorithmic Discrimination
   - 5.2 GDPR Directive in Europe
   - 5.3 Contemporary Regulatory Landscapes in Other Jurisdictions

6. Future of FinTech and AI
   - 6.1 Building Trust from Past Events
   - 6.2 New Collaboration Opportunities
   - 6.3 Future of Banking Technology
   - 6.4 Role of FinTech and AI Start-ups in Sustainable and ESG Financing
   - 6.5 Future of Banking, Cryptocurrencies and CBDCs

Literature

Compulsory Reading

Further Reading

- Arjundwadkar, P.Y. (2018) FinTech: the technology driving disruption in the financial services industry. CRC Press (Taylor & Francis Group), London.
- Chishti, S., Bartoletti, I., Leslie, A. & Millie, S.M. (2020). The AI book: the Artificial Intelligence handbook for investors, Entrepreneurs and FinTech visionaries. Wiley, West Sussex.
- Lui, A. & Ryder, N. (2021). FinTech, Artificial Intelligence and the law: regulation and crime prevention. Routledge, London.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Written Assignment, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
100 h	0 h	25 h	25 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Fraud Detection FinTechs

Course Code: DLMAIEFT02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIEFT01

Course Description

The financial services industry has been burgeoning over the last five decades, however, factors such as globalization, use of smartphones, increase in bandwidth, sophistication in technology, mobile banking and tech-savvy customers have paved the way for Financial Technology (FinTech) companies that are challenging incumbent financial institutions by offering fast, cost-effective and efficient solutions. But, as growth in FinTech companies and online business activities is sky-rocketing, various types of frauds are also increasing. Merchantsavvy, a payment comparison website stated that in 2020 the global losses that occurred due to payment fraud amounted to USD 32 billion and it includes theft of money, stealing personal property and personal data. Financial frauds have peaked during the Covid-19 pandemic as a large number of people use online channels to conduct their financial activities such as cross-border payments, investments and retail banking. Advancements in cutting-edge technologies such as machine learning, AI and algorithms are helping financial institutions to detect and prevent anomalies in transactions. Credit card frauds represent one of the important segments of fraud used by fraudulent but banks are rushing to implement two-factor authentication. Financial institutions are under immense pressure to beef up their compliance and meet increasing regulatory requirements particularly in the area of Anti-money Laundry (AML). AI-based solutions offer fast and efficient detection of frauds in a cost-effective manner which otherwise requires huge human capabilities. Banks are processing billions of transactions every month and facing the challenge of KYC as most of the customers are moving to digital accounts. This course aims to help students to explore how AI can help to detect frauds in FinTechs and also in traditional financial institutions at an early stage and how it can prevent them. Students will study different use cases, case studies and examples to enrich their knowledge.

Course Outcomes

On successful completion, students will be able to

- recognize the importance of fraud detection in FinTechs by exploring recent frauds such as Wirecard.
- analyze examples of FinTech and AI companies that are identifying and preventing frauds.
- describe different types of insurance frauds and assess how advanced analytics can help identification of frauds.
- learn how AI can be used in cross-border transactions to detect money laundering and assess the viability of various tools such as machine learning and Regtech.
- critically evaluate how financial institutions are using AI in lending, asset management and protection of personal identity.
- outline challenges of application of AI such as quality of data, shortage of qualified staff, implementation of technology and regulatory issues.

Contents

1. Introduction of Fraud Detections FinTechs
   - 1.1 The Exponential Growth of FinTechs
   - 1.2 Importance of Fraud Detection and Prevention in FinTechs
   - 1.3 Wirecard FinTech Fraud in Germany
   - 1.4 Examples of FinTech Companies Detecting Fraud
2. Insurance Fraud
   - 2.1 Nature of Insurance Frauds
   - 2.2 Application of Advanced Analytics for Fraud Detection
   - 2.3 Case Studies such as the OneConnect Smart Insurance Platform
3. Money Laundering
   - 3.1 Overview of Cross-board Payments
   - 3.2 AI Use in Crypto-assets Fraud Detection
   - 3.3 Regtech and Machine Learning for Fraud Detection
   - 3.4 Regulatory Fines and Case Studies (HSBC, BNP Paribas)
4. Identity Fraud
   - 4.1 Fraud of Personal Data
   - 4.2 Fraud Detection in Account Opening Process
   - 4.3 Accounts and Transaction Frauds

5. Key Application Areas of AI Anomaly Detection in Financial Institutions
   - 5.1 Lending
   - 5.2 Asset management
   - 5.3 Payments
   - 5.4 AI and Predictive Analytics

6. Key Challenges of AI Use in Fraud Detection in Financial Institutions
   - 6.1 Quality of Data
   - 6.2 Lack of Qualified Staff
   - 6.3 Regulatory Issues
   - 6.4 Implementation of Technology such as Biometrics
   - 6.5 Regulatory Fines and Case Studies (HSBC, BNP Paribas)

Literature

Compulsory Reading

Further Reading

- Arslanian, H. and Fischer, F. (2019). The future of finance: the impact of FinTech, AI, and crypto on financial services. Palgrave Macmillan, Cham.
- Ashfaq, M. and Randall, V.J. (2020). Wirecard: The rise and fall of a German FinTech, The Case Centre, UK.
- Boobier, T. (2020). AI and the future of banking. John Wiley & Sons Ltd, West Sussex.
- Gough, L. (2021). The CON men: a history of financial fraud and the lessons you can learn. Pearson, Harlow.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Applied Autonomous Driving

Module Code: DLMDSEAAD

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	10	300 h

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

Module Coordinator

Dr. Benjamin Lehmann (Architectures of Self-Driving Vehicles) / Dr. Benjamin Lehmann (Case Study: Localization, Motion Planning and Sensor Fusion)

Contributing Courses to Module

- Architectures of Self-Driving Vehicles (DLMDSEAAD01)
- Case Study: Localization, Motion Planning and Sensor Fusion (DLMDSEAAD02)

Module Exam Type

Module Exam	Split Exam
	Architectures of Self-Driving Vehicles • Study Format "Distance Learning": Exam, 90 Minutes Case Study: Localization, Motion Planning and Sensor Fusion • Study Format "Distance Learning": Written Assessment: Case Study

Weight of Module

see curriculum

Module Contents

Architectures of Self-Driving Vehicles

- Architectural patterns of a self-driving car
- Perception and motion control
- Social impact of autonomous vehicles

Case Study: Localization, Motion Planning and Sensor Fusion

- Algorithms for localization and navigation
- Sensor fusion methods for localization and objects tracking
- Motion planning algorithms

Learning Outcomes

Architectures of Self-Driving Vehicles

On successful completion, students will be able to

- explain and recognize the main components of a self-driving car.
- distinguish the sensor solutions for a self-driving car and adopt the best one for a given scenario.
- model and implement a simple motion control system.
- manage the main communication protocols to retrieve valuable information.
- reflect on the social impact of self-driving cars.

Case Study: Localization, Motion Planning and Sensor Fusion

On successful completion, students will be able to

- distinguish the methods used for localization, motion planning, and sensor fusion.
- apply the methods to autonomous vehicles.
- understand the main issues related to the adoption of autonomous vehicles in real-world scenarios.

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 Engineering	All Master Programmes in the IT & Technology fields

Architectures of Self-Driving Vehicles

Course Code: DLMDSEAAD01

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

Course Description

This course gives an overview of the main architectural aspects of a self-driving car. After introducing the hardware and software platforms, the course presents the sensor solutions necessary to provide environment perception for autonomous vehicles. Such perception yields the information used for motion control, including braking and steering. The fundamental concepts for the realization and implementation of motion control are presented, together with related safety issues (e.g., motion control under false information). The way in which a self-driving car exchanges information with the outside world is also discussed, and the main technologies and protocols are introduced. The last part of the course elaborates on the social impact of self-driving cars: ethics, mobility, and design.

Course Outcomes

On successful completion, students will be able to

- explain and recognize the main components of a self-driving car.
- distinguish the sensor solutions for a self-driving car and adopt the best one for a given scenario.
- model and implement a simple motion control system.
- manage the main communication protocols to retrieve valuable information.
- reflect on the social impact of self-driving cars.

Contents

1. Introduction
   - 1.1 Basic concepts and key technologies
   - 1.2 Hardware overview
   - 1.3 Software overview
   - 1.4 State of the art and open challenges
   - 1.5 Trends

2. Environment Perception
   - 2.1 Basic concepts
   - 2.2 GPS
   - 2.3 Inertial sensors
   - 2.4 Lidar and Radar
   - 2.5 Cameras

3. Moving, Braking, Steering
   - 3.1 Fundamentals
   - 3.2 Dynamics of a mobile vehicle
   - 3.3 Braking technologies
   - 3.4 Lateral and longitudinal control
   - 3.5 Safety issues

4. Communication
   - 4.1 Car2X communication
   - 4.2 Protocols
   - 4.3 Safety issues

5. Social Impact
   - 5.1 Ethics for autonomous vehicles
   - 5.2 New mobility
   - 5.3 Autonomous vehicles and design

Literature

Compulsory Reading

Further Reading

- Heinrichs, D. (2016). Autonomous driving and urban land use. In M. Maurer, J. Gerdes, B. Lenz, H. Winner (Eds.) Autonomous driving (pp. 213—231). Springer.
- Mueck, M., & Karls, I. (2018). Networking vehicles to everything: Evolving automotive solutions. Walter de Gruyter GmbH & Co KG.
- Schaub, A. (2018). Robust perception from optical sensors for reactive behaviors in autonomous robotic vehicles. Springer.
- Sjafrie, H. (2019). Introduction to self-driving vehicle technology. CRC Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Case Study: Localization, Motion Planning and Sensor Fusion

Course Code: DLMDSEAAD02

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

Course Description

This course provides the fundamental concepts and methods of localization, motion planning, and sensor fusion for mobile robotics and self-driving cars. Mobile robots and autonomous vehicles rely on the ability to perceive the environment and react to its dynamic changes.The first part of the course focuses on the representation of motion and navigation based on odometry, which is affected by errors due to information uncertainty. A possible solution is offered by localization methods which use odometry and complementary information, such as a GPS signal, to improve the estimation of the position of the autonomous vehicles within a reference frame. In this way, the vehicle is able to move towards a goal.The problems with detecting dynamic change in the environment is addressed in the last part of the course, where the methods of sensor fusion are introduced. Thanks to the fusion of multiple data sources, information can be extracted, e.g., an approaching object or a change in a situation can be revealed. The autonomous vehicle must be able to track the object and react to its movement to avoid human hazard and damage. The determination of the best trajectory to follow is addressed in the final part of the course.The course gives a hands-on overview of the main methods for localization, motion planning, and sensor fusion. The students must apply the concepts and methods to case studies involving a self-driving vehicle in two main scenarios: “on the road” and in a manufacturing facility.

Course Outcomes

On successful completion, students will be able to

- distinguish the methods used for localization, motion planning, and sensor fusion.
- apply the methods to autonomous vehicles.
- understand the main issues related to the adoption of autonomous vehicles in real-world scenarios.

Contents

1. Motion and Odometry
   - 1.1 Basic principles
   - 1.2 Motion models
   - 1.3 Navigation by odometry
   - 1.4 Holonomic and non-holonomic motion
   - 1.5 Errors

2. Local Navigation
   - 2.1 Basic concepts
   - 2.2 Path finding
   - 2.3 Obstacle avoidance

3. Localization
   - 3.1 Basic concepts
   - 3.2 Triangulation
   - 3.3 GPS
   - 3.4 Probabilistic localization
   - 3.5 Uncertainty of motion

4. Sensor Fusion
   - 4.1 Sensors
   - 4.2 Elaborating data from sensors
   - 4.3 Kalman filter
   - 4.4 Extended Kalman filter
   - 4.5 Tracking objects

5. Motion Planning
   - 5.1 Path planning
   - 5.2 Motion prediction
   - 5.3 Trajectory generation

Literature
Compulsory Reading
Further Reading ' Mitchell, H. B. (2007). Multi-sensor data fusion: An introduction. Springer. ' Siciliano, B., & Khatib, O. (Eds.). (2016). Springer handbook of robotics. Springer. ' Thrun, S. (2002). Probabilistic robotics. Communications of the ACM, 45(3), 52—57.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Artificial Intelligence in Supply Chain Management

Module Code: DLMAIESCM

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Amin Zitouni (Concepts of Artificial Intelligence in Supply Chain Management) / Prof. Dr. Amin Zitouni (Multi-Agent Systems)

Contributing Courses to Module

- Concepts of Artificial Intelligence in Supply Chain Management (DLMAIESCM01)
- Multi-Agent Systems (DLMAIESCM02)

Module Exam Type

Module Exam	Split Exam
	Concepts of Artificial Intelligence in Supply Chain Management • Study Format "Distance Learning": Written Assessment: Case Study Multi-Agent Systems • Study Format "Distance Learning": Written Assessment: Case Study

Weight of Module

see curriculum

Module Contents

Concepts of Artificial Intelligence in Supply Chain Management

- Fundamentals of Supply Chain Management
- Conceptional and mathematical introduction to key Artificial Intelligence disciplines for Supply Chains
- Models for improving transparency along Supply Chains
- Methods to support strategic and tactical decision-making in Supply Chains
- AI approaches for Supply Chain Operations
- Challenges of applying AI in Supply Chains

Multi-Agent Systems

- Concept of Agents and Multi-Agent systems
- Typology of intelligent Agents
- Agent communication and cooperation
- Multi-Agent Decision-Making
- Reinforcement Learning-Multi-Agent
- Potentials of Multi-Agent applications in Supply Chains

Learning Outcomes

Concepts of Artificial Intelligence in Supply Chain Management

On successful completion, students will be able to

- understand fundamental elements of Supply Chains and Supply Chain Management.
- describe different AI disciplines with relevance to Supply Chain Management.
- describe specific AI methods for strategic and tactical decision-making.
- evaluate AI concepts and their application fields for operational tasks in Supply Chains.
- understand important challenges of applying AI in Supply Chains.

Multi-Agent Systems

On successful completion, students will be able to

- give an overview of the fundamentals in Multi-Agent technology.
- understand relevant design principles for Multi-Agent Systems.
- design and build fundamental Multi-Agent systems.
- understand and apply common Multi-Agent decision-making strategies.
- evaluate benefits of Multi-Agent technology for various Supply Chain challenges.

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.

Concepts of Artificial Intelligence in Supply Chain Management

Course Code: DLMAIESCM01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01

Course Description

With start of the 2020s the fragility of global supply chains and their relevance for economies down to individual consumers became transparent, as global production and transportation stopped for weeks due to the Covid-19 pandemic. Results of these broken supply chains were production stops and even some empty shelves in supermarkets. Consequently, the question arises as to how new technology fields such as artificial intelligence can contribute to more resilient, more effective, and yet efficient supply chains. This course begins by explaining the current understanding of supply chains and a possible future state of it: Supply Chains 4.0. Next, the most promising artificial intelligence disciplines are presented and discussed to address the outlined challenges in the supply chain. In this context, the course presents suitable AI concepts, methods, and specific models for several relevant fields of supply chain management, which are also applicable to a variety of supply chain topics and use cases. The focus is on transparency, decision-making and operations along supply chains. The course concludes by discussing specific challenges for implementing AI in supply chains.

Course Outcomes

On successful completion, students will be able to

- understand fundamental elements of Supply Chains and Supply Chain Management.
- describe different AI disciplines with relevance to Supply Chain Management.
- describe specific AI methods for strategic and tactical decision-making.
- evaluate AI concepts and their application fields for operational tasks in Supply Chains.
- understand important challenges of applying AI in Supply Chains.

Contents

1. Fundamentals of Supply Chain Management
   - 1.1 Concept of Supply Chain and Supply Network
   - 1.2 End-to-End View of Supply Chain Management
   - 1.3 The Vision of Supply Chain 4.0

2. Conceptional and Mathematical Introduction to Key Artificial Intelligence Disciplines for Supply Chains
   - 2.1 Conventional Techniques
   - 2.2 Machine Learning Algorithms
   - 2.3 Neural Networks
   - 2.4 Robot Process Automation
   - 2.5 Multi-Agent Systems

3. Models for improving transparency along Supply Chains
   - 3.1 Customer and Churn Analytics
   - 3.2 Order Peak time Prediction
   - 3.3 Risk and Fraud Detection
   - 3.4 Spend Analytics
   - 3.5 Defect Detection and Predictive Maintenance

4. Methods to Support Strategic and Tactical Decision-Making in Supply Chains
   - 4.1 Supply Chain Network Planning
   - 4.2 Supplier Selection
   - 4.3 Replenishment Strategies
   - 4.4 Route Optimization
   - 4.5 Sales & Operations Planning

5. AI Concepts in Supply Chain Operations
   - 5.1 Supplier Communication and Purchasing
   - 5.2 Autonomous Allocation of Orders to Production Resources
   - 5.3 Dynamic Routing
   - 5.4 Object Identification in Logistics

6. Challenges of applying AI in Supply Chains
   - 6.1 The Challenge of Trust
   - 6.2 The Challenges of Capability
   - 6.3 The Challenges of Accountability
   - 6.4 The Challenges of Accessibility
   - 6.5 The Challenges of Organizational Transformation

Literature

Compulsory Reading

Further Reading

- Chopra, S. (2019): Supply chain management. Strategy, planning, and operation. Pearson.
- Hwang, I. & Jang, Y. J. (2020): Q(λ) learning-based dynamic route guidance algorithm for overhead hoist transport systems in semiconductor fabs, International Journal of Production Research, 58:4, 1199-1221. DOI: 10.1080/00207543.2019.1614692
- Masrour, T., Cherrafi, A., El Hassani, I. (2021): Artificial Intelligence and Industrial Applications: Smart Operation Management, Springer
- Park, J.; Kim, M.-H.; Choi, D.-G. (2021): Correspondence Learning for Deep Multi-Modal Recognition and Fraud Detection. Electronics 2021, 10, 800. https://doi.org/10.3390/electronics10070800
- Selvakanmani, S., Pranamita, N., Deepak, K., Kavi, B.A., Salmaan, A.K. (2020): Churn prediction using ensemble learning: an analytical CRM application. Int. J. Adv. Sci. Technol. Vol. 29, No. 5, p. 9192–9200
- Triepels, R., Daniels, H., Feelders, A. (2019): Data-driven fraud detection in international shipping, Expert Systems With Applications 99, Elsevir, p.193-202.
- Wang, C. & Jiang, P (2019). Deep neural networks based order completion time prediction by using real-time job shop RFID data. Journal of Intelligent Manufacturing, Vol. 30, No. 3, p. 1303–1318.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Multi-Agent Systems

Course Code: DLMAIESCM02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01

Course Description

In the last decade artificial intelligence has made significant progress based on breakthroughs in machine learning techniques and their wide range of application. As a result, Machine learning has become a synonym for Artificial Intelligence. This course extends the view on A. I. by introducing Multi-Agent Systems, as one of the first A. I. related fields of research. The course starts with explaining why Multi-Agent Systems will become the foundation of the next level for more sophisticated applications of Artificial Intelligence. Understanding, designing, and building Multi-Agent Systems however follow specific design principles and fundamental approaches, which are explained and discussed in this course. The topic of autonomous and distributed decision making of Agents is key for the practical relevance of Multi-Agent technology, especially in the field of Supply Chains. In this context fundamental concepts of collaboration and negotiation in Multi-Agent Systems are presented. The course concludes with connecting the Multi-Agent technology with the concept of reinforcement learning.

Course Outcomes

On successful completion, students will be able to

- give an overview of the fundamentals in Multi-Agent technology.
- understand relevant design principles for Multi-Agent Systems.
- design and build fundamental Multi-Agent systems.
- understand and apply common Multi-Agent decision-making strategies.
- evaluate benefits of Multi-Agent technology for various Supply Chain challenges.

Contents

1. Agent technology
   - 1.1 Concept of Agents and Multi-Agent Systems
   - 1.2 Agent Applications
   - 1.3 Agents Oriented Design and Methodologies
2. Typology of Intelligent Agents
   - 2.1 Reasoning Agents
   - 2.2 Reactive Agents
   - 2.3 Hybrid Agents

3. Agent Communication
   - 3.1 Ontology
   - 3.2 Communication Languages

4. Agent Cooperation
   - 4.1 Distributed Problem Solving
   - 4.2 Task and Result Sharing
   - 4.3 Handling Inconsistency
   - 4.4 Planning and Synchronization

5. Multi-Agent Decision-Making
   - 5.1 Strategies
   - 5.2 Group Decisions
   - 5.3 Coalitions
   - 5.4 Bargaining
   - 5.5 Arguing

6. Reinforcement Learning-Multi-Agent
   - 6.1 The Goal of Reinforcement Learning
   - 6.2 Benefits and Challenge
   - 6.3 Introducing Multi-Agent Reinforcement Learning Algorithms

7. Potentials of Multi-Agent Applications in Supply Chains
   - 7.1 Multi-Agents Application for Strategic and Tactical Tasks
   - 7.2 Multi-Agents Application in Operational Processes
   - 7.3 Multi-Agents Embedded in Cyber-Physical Systems

Literature
Compulsory Reading
Further Reading ' Bellifemine, F. L., Caire, G., Greenwood, D. (2007): Developing Multi-Agent Systems with JADE. Wiley. ' Bordini, R. H., Dastani, M., Dix, J., El Fallah Seghrouchni, A. (2009): Multi-Agent Programming, Languages, Tools and Applications. Springer. ' Bordini, R., Hübner, & J. F., Wooldridge, M. (2007): Programming Multi-Agent Systems in AgentSpeak using Jason. Wiley. ' Paolucci M, Sacile R (2016) Agent-based manufacturing and control systems: new agile manufacturing solutions for achieving peak performance. CRC Press. ' Shoham, Y., & Leyton-Brown, K. (2009): Multiagent Systems, Algorithmic, Game-Theoretic, and Logical Foundations. Cambridge University Press. ' Uhrmacher, A. M., & Weyns, D. (2009): Multi-Agent Systems, Simulation and Applications. CRC Press. ' Weiss, G. (2013): Multiagent Systems, The MIT Press. Cambridge.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

AI in Healthcare and Medical Imaging

Module Code: DLMAIEHCMI

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01 ' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEHCMI01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Ulrich Kerzel (AI in Healthcare) / Prof. Dr. Ulrich Kerzel (AI in Medical Imaging and Diagnostics)

Contributing Courses to Module

- AI in Healthcare (DLMAIEHCMI01)
- AI in Medical Imaging and Diagnostics (DLMAIEHCMI02)

Module Exam Type

Module Exam	Split Exam
	AI in Healthcare • Study Format "Distance Learning": Exam, 90 Minutes AI in Medical Imaging and Diagnostics • Study Format "Distance Learning": Oral Assignment

Weight of Module

see curriculum

Module Contents

AI in Healthcare

- Healthcare Stakeholders
- Drug Discovery
- Personalized Care
- Blockchain in Healthcare
- Fraud Detection
- Regulations and Ethics

AI in Medical Imaging and Diagnostics

- Introduction to Medical Imaging and Diagnostics
- Medical Imaging Techniques
- Computer Vision Fundamentals
- Computer Vision with Deep Learning
- Applications of AI in Medical Imaging & Case Studies

Learning Outcomes

AI in Healthcare

On successful completion, students will be able to

- remember the key stakeholders in healthcare.
- understand how artificial intelligence can be used in a wide range of healthcare applications.
- evaluate the impact of data driven methods and artificial intelligence in healthcare applications.
- analyze the impact of regulatory or ethical requirements on the development of data driven methods and artificial intelligence in healthcare.

AI in Medical Imaging and Diagnostics

On successful completion, students will be able to

- analyze the challenges of using artificial intelligence in medical imaging.
- understand the most common medical imaging techniques.
- apply artificial intelligence methods to medical imaging scenarios.
- create deep learning-based image analysis algorithms using medical images.

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.

AI in Healthcare

Course Code: DLMAIEHCMI01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01

Course Description

The course gives an overview over a wide range of topics in which artificial intelligence has the potential to transform the way healthcare operates. The course starts with an introduction to the key stakeholders in healthcare. Afterwards, discovery of new drugs and medicines are discussed where artificial intelligence is already starting to make a big impact. Next, the topics personalized care, blockchain in healthcare and fraud detection are discussed which are key drivers in the digitalization of healthcare in the future. Finally, the course covers the foundations of regulations and ethics in healthcare with a strong focus on data driven methods and artificial intelligence, including data protection, bias in AI and explainable AI methods.

Course Outcomes

On successful completion, students will be able to

- remember the key stakeholders in healthcare.
- understand how artificial intelligence can be used in a wide range of healthcare applications.
- evaluate the impact of data driven methods and artificial intelligence in healthcare applications.
- analyze the impact of regulatory or ethical requirements on the development of data driven methods and artificial intelligence in healthcare.

Contents

1. Healthcare Stakeholders
   - 1.1 Healthcare Management
   - 1.2 Insurance & Intermediaries
   - 1.3 Pre-Clinical & Clinical Care Providers
   - 1.4 GP & Specialist Care
   - 1.5 Industry (Pharma / Medical Products)
   - 1.6 Patents & Society
2. Drug Discovery
   - 2.1 Drug Discovery Approaches
   - 2.2 AI in Drug Discovery

3. Personalized Care
   - 3.1 Medication Monitoring
   - 3.2 Virtual Nursing Assistants

4. Blockchain in Healthcare
   - 4.1 Introduction to Blockchains & Medical Blockchains
   - 4.2 Blockchain in Organ Procurement
   - 4.3 Blockchain for Electronic Health Records (EHR)
   - 4.4 Blockchain for Pharma Supply Chain (Forged Drugs, etc)

5. Fraud Detection
   - 5.1 Introduction to Fraud Detection
   - 5.2 ICD-10 Codes
   - 5.3 Fraud Detection in Healthcare Management

6. Regulations and Ethics
   - 6.1 Legal & Regulatory Requirements
   - 6.2 Data Protection Foundations, GDPR
   - 6.3 Privacy in Machine Learning and AI
   - 6.4 Bias & Fairness in AI
   - 6.5 Explainable AI

Literature

Compulsory Reading

Further Reading

- Alleyn, T. et al (eds) (2020): Target Discovery and Validation: Methods and Strategies for Drug Discovery, Wiley.
- Antonopoulos, A. (2017): Mastering Bitcoin, 2nd ed. O'Reilley.
- Blass, B. (2015). Basic Principles of Drug Discovery and Development, Academic Press.
- Boccia, S. et al. (eds.) (2020): Personalised Health Care, Springer.
- Brown, N. (2020): Artificial Intelligence in Drug Discovery, Royal Society of Chemistry.
- Challen, R. et al. (2019). Artificial intelligence, bias and clinical safety. BMJ Quality & Safety, 28(3), 231-237.
- Costigliola, V. ed. (2012): Healthcare Overview: New Perspectives, Springer.
- Denton, B. (2013): Handbook of Healthcare Operations Management: Methods and Applications, Springer.
- Gupta, D. et al. (eds) (2020): Advanced Computational Intelligence Techniques for Virtual Reality in Healthcare, Springer.
- Hall, R. (ed) (2012): Handbook of Healthcare System Scheduling, Springer.
- IT Governance Privacy Team (2020): EU General Data Protection Regulation (GDPR) – An implementation and compliance guide, fourth edition, ITGP.
- Lantz, L., Cawrey, D. (2020): Mastering Blockchain, O'Reilley.
- Levine, A. et al. (eds) (2013) The Comprehensive Textbook of Healthcare Simulation, Springer.
- McCradden, M. D. et al. (2020). Patient safety and quality improvement: Ethical principles for a regulatory approach to bias in healthcare machine learning. Journal of the American Medical Informatics Association, 27(12), 2024-2027.
- Molnar, Ch. (2019), Interpretable Machine Learning, Lulu.
- O'Donnell, J. et al (eds.) (2021): Drug Discovery and Development, 3rd ed., CRC Press.
- Pinedo, M. (201): Scheduling: Theory, Algorithms, and Systems, 5th ed., Springer.
- Vissers, J. (2005): Health Operations Management.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

AI in Medical Imaging and Diagnostics

Course Code: DLMAIEHCMI02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEHCMI01

Course Description

The course focuses on image based medical diagnostics. The course starts with a short review of the history of image-based diagnostics and then considers general aspects of using artificial intelligence in healthcare, such as issues concerning the relevant "ground truth" data to train AI models on, integration of artificial intelligence into clinical practice and explainable AI methods. Next, the fundamentals of imaging techniques are discussed, such as X-Ray and computer aided tomography, magnetic resonance imaging, positron emission tomography and ultrasound imaging. Following the image acquisition methods, the course then turns towards image analysis techniques, starting with the fundamentals of computer vision before turning towards deep learning-based approaches. Finally, the course discusses relevant case studies and application scenarios.

Course Outcomes

On successful completion, students will be able to

- analyze the challenges of using artificial intelligence in medical imaging.
- understand the most common medical imaging techniques.
- apply artificial intelligence methods to medical imaging scenarios.
- create deep learning-based image analysis algorithms using medical images.

Contents

1. Introduction to Medical Imaging and Diagnostics
   - 1.1 History of Image-Based Diagnostics
   - 1.2 Obtaining Ground-Truth Data
   - 1.3 Domain Expertise & Integration into Clinical Practice
   - 1.4 Explainability & Bias in Medical AI
2. Medical Imaging Techniques
   - 2.1 X-Ray and Computer Aided Tomography (CT)
   - 2.2 Magnetic Resonance Imaging (MRI)
   - 2.3 Positron Emission Tomography (PET)
   - 2.4 Ultrasound Imaging

3. Computer Vision Fundamentals
   - 3.1 Low Level Computer Vision
   - 3.2 Mid Level Computer Vision
   - 3.3 High Level Computer Vision

4. Computer Vision with Deep Learning
   - 4.1 Image Classification
   - 4.2 Object Detection
   - 4.3 Image Segmentation
   - 4.4 Further Topics

5. Applications of AI in Medical Imaging & Case Studies
   - 5.1 Disease Identification
   - 5.2 Image Acquisition
   - 5.3 Survival Prediction

Literature

Compulsory Reading

Further Reading

- Banerjee, I. et al. (2021): Reading Race: AI Recognizes Patient's Racial Identity In Medical Images, arXiv preprint https://arxiv.org/abs/2107.10356.
- Bushberg, J. et al (2020): The Essential Physics of Medical Imaging, 4th ed. Wolters Kluwer Health.
- Esteva, A. et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature 542, 115–118 (2017). https://doi.org/10.1038/nature21056.
- Feeman, T. (2015): The Mathematics of Medical Imaging, 2nd ed., Springer.
- Forsyth, D., Ponce, J. (2012): Computer Vision - A Modern Approach, Prentice Hall.
- Geron, A. (2019), Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd ed., O'Reilley.
- Goodfellow et al (2016): Deep Learning, MIT Press.
- Molnar, Ch. (2019), Interpretable Machine Learning, Lulu.
- Oren, O. Gersh, B., Bhatt, D. (2020): Artificial intelligence in medical imaging: switching from radiographic pathological data to clinically meaningful endpoints, The Lancet, VOLUME 2, ISSUE 9, E486-E488, DOI: https://doi.org/10.1016/S2589-7500(20)30160-6 .
- Poldrack, R. et al (2011): Handbook of Functional MRI Data Analysis, Cambridge University Press.
- Roberts, M., Driggs, D., Thorpe, M. et al. (2021) Common pitfalls and recommendations for using machine learning to detect and prognosticate for COVID-19 using chest radiographs and CT scans. Nat Mach Intell 3, 199–217. https://doi.org/10.1038/s42256-021-00307-0.
- Smith, N., Webb, A. (2010): Introduction to Medical Imaging, Cambridge University Press.
- Stippich, Ch. (ed) (2021): Clinical Functional MRI, Springer.
- Szeliski,R. (2010):Computer Vision - Algorithms and Applications, Springer, 2010.
- Wang, S. et al (2016): Accelerating magnetic resonance imaging via deep learning, 2016 IEEE 13th International Symposium on Biomedical Imaging (ISBI).
- Wulczyn, E. et al (2021): Interpretable survival prediction for colorectal cancer using deep learning, npj Digit. Med. 4, 71, DOI: https://doi.org/10.1038/s41746-021-00427-2.
- Wynants, L. et al (2020), Prediction models for diagnosis and prognosis of covid-19: systematic review and critical appraisal, BMJ 2020;369:m1328.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

AI in E-Commerce, Marketing and Demand Forecast

Module Code: DLMAIEECMDF

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01 ' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEECMDF01	MA	10	300 h

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

Module Coordinator

N.N. Professur für Artificial Intelligence (Introduction to AI in E-Commerce and Marketing) / N.N. Professur für Artificial Intelligence (Demand Forecast and Inventory Control)

Contributing Courses to Module

- Introduction to AI in E-Commerce and Marketing (DLMAIEECMDF01)
- Demand Forecast and Inventory Control (DLMAIEECMDF02)

Module Exam Type

Module Exam	Split Exam
	Introduction to AI in E-Commerce and Marketing • Study Format "Distance Learning": Written Assessment: Case Study Demand Forecast and Inventory Control • Study Format "Distance Learning": Exam or Written Assessment: Case Study, 90 Minutes

Weight of Module

see curriculum

Module Contents

Introduction to AI in E-Commerce and Marketing

- Application Areas and Historical Review
- Virtual Assistants
- Visual Search
- Dynamic Pricing
- Regulatory Requirements & Ethics
- Case Studies

Demand Forecast and Inventory Control

- Newsvendor Model
- Traditional Methods of Demand Forecasting
- Data Driven methods of Demand Forecasting
- Inventory Models
- Further Effects

Learning Outcomes

Introduction to AI in E-Commerce and Marketing

On successful completion, students will be able to

- remember the application areas within E-Commerce and Marketing.
- understand the theory of setting prices.
- evaluate regulatory requirements and ethic considerations within the context of using artificial intelligence in E-Commerce and Marketing.
- understand the use of AI in virtual assistants and visual search.
- analyze relevant case studies.

Demand Forecast and Inventory Control

On successful completion, students will be able to

- understand the concepts of demand forecasting and inventory control.
- evaluate which method is appropriate in a specific application scenario.
- analyze which effects need to be considered in demand forecasting or inventory control models.
- create demand forecasting models using the methods discussed in the course.

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.

Introduction to AI in E-Commerce and Marketing

Course Code: DLMAIEECMDF01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01

Course Description

This course gives a general introduction to the use of artificial intelligence in the application domain of E-Commerce and Marketing. First, the general application areas are introduced and set into a historical context. This is then developed deeper in dedicated learning units focused on virtual assistants and visual search. Determining the optimal price for a product or service is crucial to all aspects in E-Commerce and Marketing, a dedicated learning unit covers the theoretical foundations before turning to discussing methods how to adapt prices dynamically. The use of artificial intelligence requires extensive use of data. In particular in marketing and E-Commerce, personal data are often processed, a dedicated learning unit covers both the regulatory aspects of which data may be processed and under which circumstances, as well as ethical considerations of how to use data responsibly within the allowed remit. Finally, a number of case studies are discussed to illustrate the use of artificial intelligence in E-Commerce and Marketing.

Course Outcomes

On successful completion, students will be able to

- remember the application areas within E-Commerce and Marketing.
- understand the theory of setting prices.
- evaluate regulatory requirements and ethic considerations within the context of using artificial intelligence in E-Commerce and Marketing.
- understand the use of AI in virtual assistants and visual search.
- analyze relevant case studies.

Contents

1. Application Areas and Historical Review
   - 1.1 Retail
   - 1.2 Entertainment
   - 1.3 Advertising
   - 1.4 Internet of Things

2. Virtual Assistants
   - 2.1 NLP Fundamentals
   - 2.2 NLP with Deep Learning
   - 2.3 Chatbots
   - 2.4 Voice Search

3. Visual Search
   - 3.1 Computer Vision Fundamentals
   - 3.2 Computer Vision with Deep Learning
   - 3.3 Visual Product Search

4. Dynamic Pricing
   - 4.1 Pricing Theory
   - 4.2 Measuring Price Elasticity
   - 4.3 Bayesian Optimal Pricing
   - 4.4 Dynamic Pricing

5. Regulatory Requirements & Ethics
   - 5.1 Data Protection and Data Privacy
   - 5.2 Ethical Data Usage and Modeling

6. Case Studies
   - 6.1 Retail
   - 6.2 Entertainment
   - 6.3 Advertisement

Literature
Compulsory Reading
Further Reading ' Chaffey, D. (2019): Digital Business and E-Commerce Management, 7th ed. Pearson. ' Forsyth, D., Ponce, J. (2012): Computer Vision - A Modern Approach, Prentice Hall. ' Friedman, D. (1986): Price Theory: An Intermediate Text, South-Western Publishing Co. ' IT Governance Privacy Team (2020): EU General Data Protection Regulation (GDPR) – An implementation and compliance guide, fourth edition, ITGP. ' Landsburg, St. (2013): Price Theory and Applications, Cengage Learning; 9th edition. ' Laudon, K./Traver, C. G. (2020): E-Commerce. Business. Technology. Society. 16. Auflage, Pearson. ' Martin, J., Jurafsky, D. (2008): Speech and Language Processing, 2nd ed., Prentice Hall. ' Rogers, D. L. (2016): The digital transformation playbook: Rethink your business for the digital age. Columbia Business School Publishing, New York. ' Szeliski,R. (2010):Computer Vision - Algorithms and Applications, Springer, 2010.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Demand Forecast and Inventory Control

Course Code: DLMAIEECMDF02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEECMDF01

Course Description

The course gives a general overview of traditional and modern methods used for demand forecasting and inventory control. Starting from the classic newsvendor model and its extensions, the course covers the fundamental aspects of dealing with uncertain demand, including censored data. The course then covers methods used for demand forecasting, starting with more traditional approaches such as exponential smoothing and ARIMA time-series analysis, as well as state-space models and structural time series-based approaches. Next, data-driven and machine learning based approaches are discussed, including methods that exploit the temporal order of, for example, sales data in the forecast and supervised methods that can be used without. To highlight the challenge in exploiting the auto-correlation, the effects of causal relationships in time-series forecasting, in particular temporal confounding are addressed. Further, methods that avoid demand forecasting altogether such as the “Big Data Newsvendor” and similar approaches are discussed. The course then turns towards inventory models, including, for example, models with review such as (s,S) based models. Finally, the course covers a range of topics that are particularly important for practical applications, such as including customer heterogeneity, or the retirement of old and inclusion of new products in the assortment, as well as discussing how to derive operational KPIs that can be used to monitor the replenishment process in practice.

Course Outcomes

On successful completion, students will be able to

- understand the concepts of demand forecasting and inventory control.
- evaluate which method is appropriate in a specific application scenario.
- analyze which effects need to be considered in demand forecasting or inventory control models.
- create demand forecasting models using the methods discussed in the course.

Contents

1. Newsvendor Model
   - 1.1 Single Period Newsvendor (Classic, Cost Function)
   - 1.2 Demand as a Stochastic Quantity
   - 1.3 Demand Models
   - 1.4 Handling Censored Data
   - 1.5 Extensions
   - 1.6 Multi-Period Newsvendor

2. Traditional Methods of Demand Forecasting
   - 2.1 Exponential Smoothing
   - 2.2 ARIMA
   - 2.3 State Space Models
   - 2.4 (Bayesian) Structural Time Series Models

3. Data Driven Methods for Demand Forecasting
   - 3.1 Recurrent Neural Networks
   - 3.2 Supervised Learning
   - 3.3 Effects of Correlation and Confounding
   - 3.4 Big Data Newsvendor

4. Inventory Models
   - 4.1 Economic Order Quantity
   - 4.2 Inventory Models with Review
   - 4.3 Inventory Models with Service Levels

5. Further Effects
   - 5.1 Customer Heterogeneity
   - 5.2 Finite Product Lifetime
   - 5.3 Minimum Order Quantity
   - 5.4 Delivery Schedules
   - 5.5 Operational KPIs and Inventory Optimization

Literature

Compulsory Reading

Further Reading

- Ban GY, Rudin C (2019) The big data newsvendor: Practical insights from machine learning. Oper Res 67(1):90–108
- Bertsimas D, Kallus N (2020) From predictive to prescriptive analytics. Manag Sci 66(3):1025–1044
- Bica I, Alaa A, Van Der Schaar M (2020) Time series deconfounder: Estimating treatment effects over time in the presence of hidden confounders. In: International Conference on Machine Learning. PMLR, pp 884–895
- Brodersen KH, Gallusser F, Koehler J, Remy N, Scott SL (2015) Inferring causal impact using Bayesian structural time-series models. Ann Appl Stat 9:247–274
- De Gooijer JG, Hyndman RJ (2006) 25 years of time series forecasting. Int J Forecast 22(3):443–473
- Galliher, H. P. , Morse, Philip M., Simond, M. (1959) Dynamics of two classes of continuous-review inventory systems. Operations Research, 7(3):362{384}
- Harris, F. (1990) How many parts to make at once. Operations Research, 38(6):947{950}.
- Hillier, F., Liebermann, G. (2020), ISE Introduction to Operations Research, McGraw-Hill
- Huber J, Müller S, Fleischmann M, Stuckenschmidt H (2019) A data-driven newsvendor problem: From data to decision. Eur J Oper Res 278(3):904–915
- Hyndman R, Koehler AB, Ord JK, Snyder RD (2008) Forecasting with exponential smoothing: the state space approach. Springer Science & Business Media
- Khouj, M (1999) The single-period (news-vendor) problem: literature review and suggestions for future research. Omega 27(5):537–553
- Längkvist M, Karlsson L, Loutfi A (2014) A review of unsupervised feature learning and deep learning for time-series modeling. Pattern Recogn Lett 42:11–24
- Lim B, Arik SO, Loeff N, Pfister T (2019) Temporal fusion transformers for interpretable multi-horizon time series forecasting. arXiv preprint arXiv:1912.09363
- Malinsky D, Spirtes P (2018) Causal structure learning from multivariate time series in settings with unmeasured confounding. In: Proceedings of 2018 ACM SIGKDD Workshop on Causal Discovery, pp 23–47
- Nahmias, S. , Pierskalla, W. (1973) Optimal ordering policies for a product that perishes in two periods subject to stochastic demand. Naval Research Logistics Quarterly, 20(2):207{229, 1973.
- Porteus, E. (1983) Inventory Policies for Periodic Review Systems. Research Papers 650, Stanford University, Graduate School of Business, June 1983.
- Rasul K, Sheikh AS, Schuster I, Bergmann U, Vollgraf R (2020) Multi-variate probabilistic time series forecasting via conditioned normalizing flows. arXiv preprint arXiv:2002.06103
- Runge J (2018) Causal network reconstruction from time series: From theoretical assumptions to practical estimation. Chaos Int J Nonlinear Sci 28(7):075310
- Scarf, H. (1959) Bayes solutions of the statistical inventory problem. Ann. Math. Statist., 30(2):490{508, 06
- Vandeput, N. (2020) Inventory Optimization: Models and Simulations, De Gruyter
- Wick, F. et al. (2021) Demand Forecasting of Individual Probability Density Functions with Machine Learning. SN Oper. Res. Forum 2, 37. https://doi.org/10.1007/s43069-021-00079-8

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Case Study, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
100 h	0 h	25 h	25 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Industrial AI

Module Code: DLMAIEIAI

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMDSML01, DLMDSDL01, DLMAIRIL01 ' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIEIAI01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Leonardo Riccardi (AI in Production) / Prof. Dr. Marian Benner-Wickner (Project: Industrial Internet of Things)

Contributing Courses to Module

- AI in Production (DLMAIEIAI01)
- Project: Industrial Internet of Things (DLMAIEIAI02)

Module Exam Type

Module Exam	Split Exam
	AI in Production • Study Format "Distance Learning": Oral Assignment Project: Industrial Internet of Things • Study Format "Distance Learning": Oral Project Report

Weight of Module

see curriculum

Module Contents

AI in Production

- Introduction to Smart Factory
- AI for Design
- AI for Quality
- AI for Supply Chain
- AI for autonomous planning and Scheduling

Project: Industrial Internet of Things

In this course the student will learn how to design a basic IIoT system which uses common protocols, data sources, sensors and architectural paradigms of the industrial field.

Learning Outcomes

AI in Production

On successful completion, students will be able to

- understand the evolution of automation in production.
- understand the main characteristics and goals of a Smart Factory.
- name some areas in which AI can be successfully adopted in production systems.
- describe some use cases of AI in production.

Project: Industrial Internet of Things

On successful completion, students will be able to

- understand industrial use-cases of internet of things.
- understand commonly used devices and protocols.
- work with diverse industrial data sources and sensors.
- describe data flows within production facilities.
- design a basic IoT architecture for industrial scenarios.
- understand cybersecurity issues and consider them for the design of an industrial IoT architecture.

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 Engineering.	All Master Programs in the IT & Technology field.

AI in Production

Course Code: DLMAIEIAI01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01

Course Description

Production is undergoing a revolution thanks to the adoption of AI technologies, both for single processes and strategic decisions. This course gives an overview on the changing production paradigm, introducing the concept and the main characteristics of a smart factory. After that, the course illustrates some common uses cases of AI in production, such as Design, Quality, Supply Chain, and autonomous planning and scheduling, the latter being very important for the successful implementation of cyber-physical systems in the context of the industrial internet of things.

Course Outcomes

On successful completion, students will be able to

- understand the evolution of automation in production.
- understand the main characteristics and goals of a Smart Factory.
- name some areas in which AI can be successfully adopted in production systems.
- describe some use cases of AI in production.

Contents

1. Introduction: The Smart Factory
   - 1.1 Goals of a Smart Factory
   - 1.2 Internet of Things
   - 1.3 Cyber-Physical Systems
   - 1.4 Cyber-Physical Production Systems
   - 1.5 A New Paradigm for Automation
2. Basics of a Smart Factory
   - 2.1 Intelligent Products, Object Identification and Digital Object Memory
   - 2.2 Formal Languages and Ontologies
   - 2.3 Autonomous Cooperation
   - 2.4 Humans & Machines
   - 2.5 Order-Controller Production
   - 2.6 Smart Services

3. AI for Design
   - 3.1 Generative Design
   - 3.2 Methods

4. AI for Quality
   - 4.1 Fault Detection & Identification
   - 4.2 Predictive and Prescriptive Maintenance
   - 4.3 Defect Recognition

5. AI for Supply Chain
   - 5.1 Demand Forecasting
   - 5.2 Inventory Models

6. AI for Autonomous Planning and Scheduling
   - 6.1 Introduction
   - 6.2 Methods

Literature

Compulsory Reading

Further Reading

- Dafflon, B. Moalla, N., & Ouzrout, Y. (2021). The challenges, approaches, and used techniques of CPS for manufacturing in Industry 4.0: a literature review. The International Journal of Advanced Manufacturing Technology, 113(7), 2395–2412. https://doi.org/10.1007/s00170-020-06572-4
- Mahmood, Z. (Ed.). (2019). The Internet of Things in the Industrial Sector. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-24892-5
- Manesis, S., & Nikolakopoulos, G. (2020). Introduction to industrial automation. CRC Press, Taylor & Francis Group.
- Singh, K. K., Nayyar, A., Tanwar, S., & Abouhawwash, M. (Eds.). (2021). Emergence of Cyber Physical System and IoT in Smart Automation and Robotics. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-66222-6

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Project: Industrial Internet of Things

Course Code: DLMAIEIAI02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIEIAI01

Course Description

By means of AI, data generated during a production process (or a complete product lifecycle) can be effectively analyzed and leveraged to achieve improvements in the sense of productivity, design, quality, customer satisfaction, strategic planning. This course gives a hands-on introduction to how the data is generated, i.e., which are the processes and devices, what is a typical industrial data flow, what is a typical hardware and software architecture of the industrial internet of things. Attention is given to common cybersecurity issues, which should play a fundamental role while designing an effective, secure architecture.

Course Outcomes

On successful completion, students will be able to

- understand industrial use-cases of internet of things.
- understand commonly used devices and protocols.
- work with diverse industrial data sources and sensors.
- describe data flows within production facilities.
- design a basic IoT architecture for industrial scenarios.
- understand cybersecurity issues and consider them for the design of an industrial IoT architecture.

Contents

- In this course the student will learn how to design a basic IIoT system which uses common protocols, data sources, sensors and architectural paradigms of the industrial field.

Literature
Compulsory Reading
Further Reading ' Dafflon, B., Moalla, N., & Ouzrout, Y. (2021). The challenges, approaches, and used techniques of CPS for manufacturing in Industry 4.0: a literature review. The International Journal of Advanced Manufacturing Technology, 113(7), 2395–2412. https://doi.org/10.1007/s00170-020-06572-4 ' Manesis, S., & Nikolakopoulos, G. (2020). Introduction to industrial automation. CRC Press, Taylor & Francis Group. ' Veneri, G., & Capasso, A. (2018). Hands-On Industrial Internet of Things. Packt. Retrieved from https://www.packtpub.com/product/hands-on-industrial-internet-of-things/9781789537222

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Oral Project Report

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Natural Language Processing and Voice Assistants

Module Code: DLMAIWNLPVA

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMDSML01, DLMDSDL01 ' DLMDSML01, DLMDSDL01, DLMAIWNLPVA01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Tim Schlippe (Natural Language Processing) / Prof. Dr. Tim Schlippe (Voice Assistants)

Contributing Courses to Module

- Natural Language Processing (DLMAIWNLPVA01)
- Voice Assistants (DLMAIWNLPVA02)

Module Exam Type

Module Exam	Split Exam
	Natural Language Processing • Study Format "Distance Learning": Oral Assignment Voice Assistants • Study Format "Distance Learning": Portfolio

Weight of Module

see curriculum

Module Contents

Natural Language Processing

- Introduction to NLP
- Important Basic and Advanced Methods in NLP
- Relevant Applications in NLP
- Challenges in NLP and their Solutions

Voice Assistants

In this course, the implementation of voice assistants with state-of-the-art methods and frameworks will be taught.

Learning Outcomes

Natural Language Processing

On successful completion, students will be able to

- get a good overview of the topic NLP.
- name important challenges in NLP.
- apply common algorithms and methods to address NLP problems.
- understand common use-case scenarios in which NLP techniques are applied.
- analyze benefits and shortcomings of various NLP algorithms.

Voice Assistants

On successful completion, students will be able to

- implement voice assistant technology.
- understand use-case scenarios for voice assistants.
- analyze benefits and shortcomings of methods and frameworks for the implementation.
- combine the NLP components required for the implementation.
- explain the design choices made in the selection of the employed model and its implementation.
- apply common algorithms and methods to address NLP problems.

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 Data Science & Artificial Intelligence.	All Master Programs in the IT & Technology field.

Natural Language Processing

Course Code: DLMAIWNLPVA01

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

Course Description

In this course, traditional, state-of-the-art basic and advanced approaches to Natural Language Processing (NLP) will be taught. To achieve this goal, techniques, challenges, and solutions are presented with a comprehensive overview of related topics. Additionally, it will be shown how NLP can be used successfully in different use-case scenarios–both theoretically and with practical examples.

Course Outcomes

On successful completion, students will be able to

- get a good overview of the topic NLP.
- name important challenges in NLP.
- apply common algorithms and methods to address NLP problems.
- understand common use-case scenarios in which NLP techniques are applied.
- analyze benefits and shortcomings of various NLP algorithms.

Contents

1. Introduction to NLP
   - 1.1 What is NLP?
   - 1.2 Syntax, Semantics and Prosodics
   - 1.3 Phonetics and Speech
   - 1.4 Evaluation of NLP Systems
2. Text Processing
   - 2.1 Word Vectors and Word Embeddings
   - 2.2 Regular Expressions
   - 2.3 Statistical Approaches
   - 2.4 Recurrent Neural Network based Approaches
   - 2.5 Transformer based Approaches
3. Speech Processing
   - 3.1 Statistical Speech Recognition and Synthesis
   - 3.2 Speech Recognition and Synthesis with Deep Learning

4. Application Scenarios
   - 4.1 Speech Recognition, Speech Synthesis and Machine Translation
   - 4.2 Information Extraction and Text Understanding
   - 4.3 Chatbots and Voice Assistants
   - 4.4 NLP in Education
   - 4.5 NLP with Python

5. Challenges in NLP
   - 5.1 Data for NLP
   - 5.2 Domain and Language Adaptation
   - 5.3 Explainability
   - 5.4 Bias

Literature

Compulsory Reading

Further Reading

- Bird S., Klein, E., & Loper, E. (2009): Natural language processing with Python. O'Reilly.
- Jurafsky, D., & Martin, J. H. (2020): Speech and language processing (3rd ed.). PrenticeHall. https://web.stanford.edu/~jurafsky/slp3
- Kamath, U., Liu, J., & Whitaker, J. (2019): Deep Learning for NLP and Speech Recognition: Practical NLP, Speech, and Deep Learning using Python-based Open Source Tools. Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Voice Assistants

Course Code: DLMAIWNLPVA02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIWNLPVA01

Course Description

In this course, the implementation of voice assistants with state-of-the-art methods and frameworks will be taught. To achieve this goal in a structured manner, the student will step-wise submit deliverables in a conception phase, a development/reflection phase, and in a finalization phase. In each phase the student will get feedback by the tutor to iteratively enhance and extent the implementation.

Course Outcomes

On successful completion, students will be able to

- implement voice assistant technology.
- understand use-case scenarios for voice assistants.
- analyze benefits and shortcomings of methods and frameworks for the implementation.
- combine the NLP components required for the implementation.
- explain the design choices made in the selection of the employed model and its implementation.
- apply common algorithms and methods to address NLP problems.

Contents

- The practical implementation and development of a voice assistant with digital documentations is combined as part of a portfolio which is designed and carried out individually but supervised by the responsible tutor. The implementation consists of three phases–the “conception phase”, the “development/reflection phase” and the “finalization phase”–which are intended to illustrate the individual work or development steps and the adopted approach. In the conception phase, the concept or core idea should be introduced as well as the initial motivation. Implementation of the basic ideas takes place in the implementation/reflection phase. In the finalization phase, the final product and/or a final version of the written assessment are developed and delivered.

Literature
Compulsory Reading
Further Reading ' Bird S., Klein, E., & Loper, E. (2009): Natural language processing with Python. O'Reilly. ' Bocklisch, T., Faulker, J., Pawlowski, N., Nichol, A. (2017): Rasa: Open Source Language Understanding and Dialogue Management. NIPS Workshop on Conversational AI. ' Jurafsky, D., & Martin, J. H. (2020): Speech and language processing (3rd ed.). PrenticeHall. https://web.stanford.edu/~jurafsky/slp3 ' Kamath, U., Liu, J., & Whitaker, J. (2019): Deep Learning for NLP and Speech Recognition: Practical NLP, Speech, and Deep Learning using Python-based Open Source Tools. Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Portfolio

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Foundational Computer Vision

Module Code: DLMAIWFCV

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSML01, DLMDSDL01, DLMAIRIL01	MA	10	300 h

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

Module Coordinator

N.N (Image Processing and Low Level Vision) / N.N (Mid-Level Vision and Video)

Contributing Courses to Module

- Image Processing and Low Level Vision (DLMAIWFCV01)
- Mid-Level Vision and Video (DLMAIWFCV02)

Module Exam Type

Module Exam	Split Exam
	Image Processing and Low Level Vision • Study Format "Distance Learning": Exam, 90 Minutes Mid-Level Vision and Video • Study Format "Distance Learning": Oral Assignment

Weight of Module

see curriculum

Module Contents

Image Processing and Low Level Vision

- Image Acquisition
- Single and Multi-View Geometry
- Image Representation and Morphology
- Filtering
- Texture

Mid-Level Vision and Video

- Mid-Level Image Features
- Segmentation
- Motion
- Tracking
- Shape

Learning Outcomes

Image Processing and Low Level Vision

On successful completion, students will be able to

- understand fundamental concepts in image acquisition.
- compare different approaches to establish the image geometry.
- recognize different image types.
- know how to apply morphological operations.
- explain image filtering in the spatial and frequency.
- summarize common approaches to texture representation.

Mid-Level Vision and Video

On successful completion, students will be able to

- describe important types of midlevel image features.
- differentiate between region and outline based forms of image segmentation.
- understand the principles of motion estimation.
- explain different approaches to object tracking.
- appraise the role of shape in image understanding.
- remember the most common approaches to shape inference.

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.

Image Processing and Low Level Vision

Course Code: DLMAIWFCV01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01

Course Description

This course provides an exposition to the foundational aspects of image processing and computer vision. Starting from an overview on image acquisition the topic of image geometry is explored. Subsequently, common digital image representations are introduced together with basic morphological operations on them. The course closes with an introduction to filtering and texture representation.

Course Outcomes

On successful completion, students will be able to

- understand fundamental concepts in image acquisition.
- compare different approaches to establish the image geometry.
- recognize different image types.
- know how to apply morphological operations.
- explain image filtering in the spatial and frequency.
- summarize common approaches to texture representation.

Contents

1. Image Acquisition
   - 1.1 The Human Visual System
   - 1.2 Cameras and Sensors
2. Single and Multi-View Geometry
   - 2.1 Camera Geometry and Perspective Projection
   - 2.2 Stereopsis and Multiple Views
3. Image Representation and Morphology
   - 3.1 Image Types
   - 3.2 Morphology of Binary and Greyscale Images
4. Filtering
   - 4.1 Filtering in the Spatial Domain
   - 4.2 Fourier Transformation and Filtering in the Frequency Domain

5. Texture
   - 5.1 Classical Texture Representations
   - 5.2 Bag of Words and Representation in CNNs

Literature

Compulsory Reading

Further Reading

- Forsyth, D., Ponce, J. (2012): Computer Vision - A Modern Approach, Prentice Hall.
- Gonzalez, R.C., Woods, R.E. (2017): Digital Image Processing (4th edition), Prentice-Hall.
- Hartley, R., Zisserman, A. (2004): Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press.
- Klette, R. (2014): Concise Computer Vision: An Introduction into Theory and Algorithms, Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Mid-Level Vision and Video

Course Code: DLMAIWFCV02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01

Course Description

This course treats subjects that belong to the mid-level of the Computer Vision hierarchy. In particular, important image features like lines, edges, corners and other points of interest will be introduced. Based on this, an overview on segmentation and shape inference is given. Moreover, in the course the relevant topics of motion estimation and tracking are covered.

Course Outcomes

On successful completion, students will be able to

- describe important types of midlevel image features.
- differentiate between region and outline based forms of image segmentation.
- understand the principles of motion estimation.
- explain different approaches to object tracking.
- appraise the role of shape in image understanding.
- remember the most common approaches to shape inference.

Contents

1. Mid-Level Image Features
   - 1.1 Edges & Lines
   - 1.2 Corners, Points of Interest, and Blobs
   - 1.3 Feature Based Alignment
2. Segmentation
   - 2.1 Region Based Segmentation
   - 2.2 Contour Based Segmentation
3. Motion
   - 3.1 Optical Flow
   - 3.2 Classical Approaches
   - 3.3 CNN Based Methods

4. Tracking
   - 4.1 Kalman Filters
   - 4.2 Particle Filters
   - 4.3 Tracking Via Deep Networks

5. Shape
   - 5.1 Shape from X
   - 5.2 Geometric Methods
   - 5.3 Radiometric Approaches

Literature

Compulsory Reading

Further Reading

- Davies, E.R. (2012). Computer and Machine Vision. 4th edition. Academic Press. London, Oxford, Boston, New York and San Diego.
- Forsyth, D., Ponce, J. (2012): Computer Vision - A Modern Approach, Prentice Hall.
- Klette, R. (2014): Concise Computer Vision: An Introduction into Theory and Algorithms, Springer.
- Szeliski, R. (2010): Computer Vision - Algorithms and Applications, Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Management

Module Code: DLMMANE

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	None	MBA	10	300 h

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

Module Coordinator

Prof. Dr. Georg Berkel (Leadership) / Prof. Dr. Josephine Zhou-Brock (Strategic Management)

Contributing Courses to Module

- Leadership (DLMBLSE01)
- Strategic Management (DLMBSME01)

Module Exam Type

Module Exam	Split Exam
	Leadership • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Strategic Management • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

Leadership

- Foundations and concepts of strategic management
- Strategic planning process
- International challenges of strategic management

Strategic Management

- Foundations of professional leadership
- Leadership and motivation in the corporation
- Leadership and corporate culture
- Leadership and change management

Learning Outcomes

Leadership

On successful completion, students will be able to

- recognize underlying beliefs and attitudes towards leadership and compare the influence of various theories of leadership on the identification and development of leaders.
- recognize the impact of cultural environments on leadership, and understand the challenges and opportunities of cross-cultural management.
- outline the influence of social roles on leaders and employees, and assess the influence of roles types on the interactions between leaders and those they are leading.
- ,as a leader, support employees by drawing on empirical evidence to effectively meet the expectations of employees.
- recognize the roles and conflicting interests inherent to leadership positions and develop strategies to address locomotion and cohesion.
- discriminate between effective and non-effective methods for managing staff and organizational activities, and apply those techniques and tools in practice to maximize the satisfaction and effectiveness of staff.
- perform the various responsibilities delegated to a leader such as communicate with employees, lead planning activities, delegate tasks, and plan and lead controlling activities.
- create a plan to support employees through the process of change within an organization.
- assess personal leadership style using a variety of measures and evaluate leadership activities relative to transactional and transformational leadership styles.

Strategic Management

On successful completion, students will be able to

- understand the entire process of strategic planning from the organizational planning, the implementation to the evaluation and controlling.
- apply appropriate analysis tools in order to methodically address specific business decisions in the international business environment, taking intercultural aspects into account.
- analyze the capabilities of various organizations, that operate in different fields, from a functional and resource perspective by evaluating its strengths and weaknesses.
- develop a better understanding of the wider business environment by analyzing the opportunities and threats facing their organization.
- evaluate strategies by employing appropriate controlling tools.

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 Business Administration & Management	All Master Programmes in the Business & Management fields

Leadership

Course Code: DLMBLSE01

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

Course Description

In today's knowledge-based society, employees are a firm's most valuable resource. A key responsibility of leadership is to develop the knowledge, expertise, and skills of employees. Good leadership is crucial for the continued success of a firm in the face of increasingly competitive markets. This course presents the necessary competencies of the leader in a modern, knowledge-based organization. Central questions raised by modern leadership theory are presented and discussed. In doing so, the course focuses on requirements and instruments of professional leadership, aspects of situational leadership, and leadership communication and interactions, both in the context of strategic management and change processes. The methodological and conceptual foundations of leadership are presented to students, along with empirical examples and best-practice principles, with the intent for students to master the challenges of enhancing the firm's most valuable asset—its employees—via professional and contemporary leadership practices.

Course Outcomes

On successful completion, students will be able to

- recognize underlying beliefs and attitudes towards leadership and compare the influence of various theories of leadership on the identification and development of leaders.
- recognize the impact of cultural environments on leadership, and understand the challenges and opportunities of cross-cultural management.
- outline the influence of social roles on leaders and employees, and assess the influence of roles types on the interactions between leaders and those they are leading.
- ,as a leader, support employees by drawing on empirical evidence to effectively meet the expectations of employees.
- recognize the roles and conflicting interests inherent to leadership positions and develop strategies to address locomotion and cohesion.
- discriminate between effective and non-effective methods for managing staff and organizational activities, and apply those techniques and tools in practice to maximize the satisfaction and effectiveness of staff.
- perform the various responsibilities delegated to a leader such as communicate with employees, lead planning activities, delegate tasks, and plan and lead controlling activities.
- create a plan to support employees through the process of change within an organization.
- assess personal leadership style using a variety of measures and evaluate leadership activities relative to transactional and transformational leadership styles.

Contents

1. An Overview of Leadership
   - 1.1 Leadership and Personality: Trait Theories
   - 1.2 Leadership as a Skill: Attribute and Behavior Theories
   - 1.3 Positive Reinforcement: Behavioral Theories
   - 1.4 Leadership Dependent on the Situation: Situational Approaches
   - 1.5 Situational and Contingency Theories
   - 1.6 Theory of Functional Leadership Behavior
   - 1.7 Integrated Psychological Theory
   - 1.8 Transactional and Transformative Leadership
   - 1.9 Leadership as an Emotionally Charged Process
   - 1.10 Neo-Emergent Theory

2. Leadership as a Social Role
   - 2.1 Roles and Groups
   - 2.2 Role Types
   - 2.3 Formal Conditions for Social Roles – Corporate Context Determining Roles in Organizations
   - 2.4 The Individual and The Group – Conforming and Deviating Behavior
   - 2.5 The Problems of Formalized Role Understanding and Self-Concept

3. Leadership from the Employee's Perspective
   - 3.1 General Expectations for Managers
   - 3.2 Truthfulness and Authenticity
   - 3.3 Handling Conflicts Competently
   - 3.4 Conflicts in Groups
   - 3.5 Conflict Resolution Pattern According to Matzat
   - 3.6 Enthusiasm
   - 3.7 Ability to Cope with Pressure
   - 3.8 Assertiveness
   - 3.9 Empathy
   - 3.10 Expertise

4. Leadership from the Manager's Perspective
   - 4.1 Self-Concept as a Manager
   - 4.2 Locomotion and Cohesion
   - 4.3 Individual Problems and Learning Dimensions of Management Behavior
   - 4.4 The Concept of Human Nature and Its Influence on Management Behavior: Theories from Maslow, McGregor, and Herzberg
   - 4.5 Ambiguity Tolerance

5. Management Tools
   - 5.1 Management Tools - Definition
   - 5.2 Organizational Management Tools
   - 5.3 Personnel Management Tools

6. Managerial Functions
   - 6.1 Responsibilities of a Manager
   - 6.2 Communication
   - 6.3 Foundations of Interpersonal Communication
   - 6.4 Planning
   - 6.5 Setting Objectives
   - 6.6 Delegating
   - 6.7 Controlling
   - 6.8 Creating a Feedback Culture

7. Organizational Change
   - 7.1 Knowledge
   - 7.2 Cultural Value Change and Subjectification
   - 7.3 Globalization
   - 7.4 Technological Progress
   - 7.5 Change Management – Leadership in Times of Change

8. Successful Employee Management
   - 8.1 Measuring Leadership Style and Leadership Behavior
   - 8.2 Measuring Transactional and Transformational Leadership with the Multifactor Leadership Questionnaire (MLQ)
   - 8.3 Correlation of Leadership Behavior with Subjective and Objective Success Criteria
   - 8.4 Validation of Leadership Success Using Situational Factors
   - 8.5 Leadership Principles Guiding Leadership Behavior

Literature

Compulsory Reading

Further Reading

- Gneezy, U., & Rustichini, A. (2000). Pay enough or don't pay at all. The Quarterly Journal of Economics,115(3), 791–810. (Database: EBSCO).
- Goleman, D., Boyatzis, R., & McKee, A. (2004). Primal leadership: Learning to lead with emotionalintelligence. Boston, MA: Harvard Business School Press.
- Hechter, M., & Opp, K.-D. (2001). Social norms. New York, NY: Russell Sage Foundation.
- Herzberg, F., Mausner, B., & Bloch Synderman, B. (1993). The motivation to work. New Brunswick:Transaction Publishers. (Database: EBSCO).
- Kouzes, J. M., & Posner, B. Z. (1999). Encouraging the heart: A leader's guide to rewarding and recognizingothers. San Francisco, CA: Jossey-Bass. (Database: CIANDO).
- Maslow, A. (1954). Motivation and personality. New York, NY: Harper & Row.
- Norton, R. W. (1975). Measurement of ambiguity tolerance. Journal of Personality Assessment, 39(6), 607–619. (Database: EBSCO).
- Trilling, L. (1972). Sincerity and authenticity. Cambridge, MA: Harvard University Press. (Database: EBSCO).

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☑ Vodcast	☐ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☑ Slides
☑ Exam Template	

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☑ Vodcast	☐ Guideline
☐ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☑ Slides
☑ Exam Template	

Strategic Management

Course Code: DLMBSME01

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

Course Description

Various methods of strategic market analysis are presented in this course so as to allow students to evaluate risks and opportunities in global markets, highlighting intercultural aspects, by looking at organizations operating in different countries. Students learn to analyze and understand strengths and weaknesses of organizations from various disciplines (products, services, NGOs etc.) that face specific market situations. Supported by new developments in the field of market research, the process for identifying and analyzing core competencies and competitive advantages in national and international environments is discussed at length. Students are supported to plan strategic alternatives and to implement and control these by taking on fictitious roles within various different organizations. Exercises and international case studies help students to identify with the role of management and participate in the strategic planning process as well as in operational management. This helps students understand the problems companies regularly face and comprehend how methods of modern management can be used in order to solve these.

Course Outcomes

On successful completion, students will be able to

- understand the entire process of strategic planning from the organizational planning, the implementation to the evaluation and controlling.
- apply appropriate analysis tools in order to methodically address specific business decisions in the international business environment, taking intercultural aspects into account.
- analyze the capabilities of various organizations, that operate in different fields, from a functional and resource perspective by evaluating its strengths and weaknesses.
- develop a better understanding of the wider business environment by analyzing the opportunities and threats facing their organization.
- evaluate strategies by employing appropriate controlling tools.

Contents

1. What is Strategy?
   - 1.1 What is a Corporate Strategy?
   - 1.2 What Has to be Taken into Consideration when Making Strategic Decisions?
   - 1.3 Who Takes Part in Developing a Strategy?
   - 1.4 What is Included in a Solid Strategic Plan?

2. The Strategic Environment
   - 2.1 Where Are We in the Market Place? The Macro Environment
   - 2.2 Where Are We in the Market Place? The Micro Environment
   - 2.3 Analysis, Strategic Capabilities, and the Five Forces Model

3. The Position in the Market
   - 3.1 Why Do We Exist?
   - 3.2 What is Our Position in the Market?
   - 3.3 What Information Does the Company Need?
   - 3.4 What Capabilities Does the Company Have?
   - 3.5 What Capabilities Do Others Have?

4. What Strategic Options Are Available to the Strategic Business Unit (SBU)?
   - 4.1 What Strategic Options Does the SBU Have?
   - 4.2 Interactive Strategies
   - 4.3 Product Life Cycle

5. What Strategic Options Are Available to the Corporation?
   - 5.1 Areas to Consider When Formulating a Strategy
   - 5.2 Strategic Options
   - 5.3 Outsourcing
   - 5.4 Product Portfolio Analysis Using the BCG Matrix
   - 5.5 Product Portfolio Analysis Using the GE-McKinsey Matrix

6. What International Strategies Are Available?
   - 6.1 Why Do Companies Go International?
   - 6.2 What Factors Contribute to the Decision About Which Country to Invest In?
   - 6.3 How Can a Company Invest Internationally?

7. Do-It-Yourself, Buy, or Ally?
   - 7.1 Do-It-Yourself
   - 7.2 Mergers and Acquisitions (M&As)
   - 7.3 Strategic Alliances
   - 7.4 How to Decide Whether to Buy, Alley, or Do-It-Yourself?

8. How to Evaluate Strategies?
   - 8.1 How to Evaluate Strategy?
   - 8.2 Implementing Strategy

Literature

Compulsory Reading

Further Reading

- Hooley, G. J., Piercy, N., Nicoulaud, B., & Rudd, J. M. (2017). Marketing strategy and competitive positioning (6th ed.). Harlow: Pearson Education.
- Johnson, G., Whittington, R., Scholes, K., Angwin, D., & Regnér, P. (2017). Exploring strategy: Text and cases (10th ed.). Harlow: Pearson Education.
- Kotler, P. T., & Keller, K. L. (2015). Marketing management (15th ed.). Harlow: Pearson.
- Porter, M. (2004). Competitive strategy: Techniques for analyzing industries and competitors. New York, NY: Free Press.
- Porter, M. (2008). On competition (2nd ed.). Boston: Harvard Business Review Press.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Sales, Pricing and Brand Management

Module Code: DLMBSPBE

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	10	300 h

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

Module Coordinator

Caterina Fox (Global Brand Management) / Caterina Fox (Sales and Pricing)

Contributing Courses to Module

- Global Brand Management (DLMBSPBE01)
- Sales and Pricing (DLMBSPBE02)

Module Exam Type

Module Exam	Split Exam
	Global Brand Management • Study Format "Distance Learning": Exam, 90 Minutes Sales and Pricing • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

Global Brand Management

For most companies, a major opportunity to grow their business involves looking for possibilities outside their native country. However, taking brands beyond national boundaries presents a new set of branding issues as the global marketplace is constantly changing. At the same time, various forms of regionalization are taking place, adding another layer of complexity to managing a brand portfolio. Arguably, products, pricing and distribution are increasingly becoming commodities and the new competitive arena is brand value, creating long-term, profitable brand relationships. Ultimately, strong brands will transcend industries and provide an organization with one of its most valuable assets. This course ultimately aims to introduce students to the differentiation of products and services in a world of alternatives and the benefits/disadvantages of providing customers with the power of choice.

Sales and Pricing

Establishing and maintaining a competitive customer interface is one of the major challenges for every company to assure successful revenue- and profit-management. The course will allow students to understanding the optimization levers of the customer interface. This includes advanced methods of market- and customer segmentation, channel management including the design, setup and optimization of a customer oriented sales organization (e.g. key account management), practices for sales-force-effectiveness, sales optimization levers, e.g. for customer penetration, and methods for price-differentiation and -realization. The course incorporates case-studies and practice related data and for each optimization lever, students are introduced to a comprehensive tool-box approach. The tool box for each lever contains the required theory, a set of basic analyses and the application of best-practice examples and metrics.

Learning Outcomes

Global Brand Management

On successful completion, students will be able to

- analyze brands, brand components and brand management.
- examine how brands are positioned and re-positioned in regional, national and international markets and explore the concept of shared- and co-operative branding.
- promote the importance of brand valuation and measurement techniques within their company.
- form and apply tactics to address brand falsification and protection as well as to develop strategies to manage a brand crisis.
- analyze the main challenges facing international brands, and be able to measure their brand equity
- understand the factors that contribute to increasing or losing consumer-based brand equity.
- analyze a company's current brand strategy and propose viable alternatives as well as make informed decisions with greater probability of success.

Sales and Pricing

On successful completion, students will be able to

- identify the key-success factors for modern sales organizations.
- describe the relationship between segmentation and the design of an appropriate sales organization.
- execute respective analyses and apply improvement levers.
- demonstrate the use of the tool-boxes for the respective optimization levers.
- identify major characteristics of a high-performance sales organization.
- conduct decisive analyses to assess the strength and weaknesses of a sales organization and identify respective optimization levers.
- implement the required organizational and process-related improvement levers.
- measure the performance of a sales-organization using established methods, KPIs and metrics.
- apply fundamental concepts of international pricing.

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 Marketing & Sales.	All Master Programmes in the Marketing field.

Global Brand Management

Course Code: DLMBSPBE01

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

Course Description

For most companies, a major opportunity to grow their business involves looking for possibilities outside their native country. However, taking brands beyond national boundaries presents a new set of branding issues as the global marketplace is constantly changing. At the same time, various forms of regionalization are taking place, adding another layer of complexity to managing a brand portfolio. Arguably, products, pricing and distribution are increasingly becoming commodities and the new competitive arena is brand value, creating long-term, profitable brand relationships. Ultimately, strong brands will transcend industries and provide an organization with one of its most valuable assets. This course ultimately aims to introduce students to the differentiation of products and services in a world of alternatives and the benefits/disadvantages of providing customers with the power of choice.

Course Outcomes

On successful completion, students will be able to

- analyze brands, brand components and brand management.
- examine how brands are positioned and re-positioned in regional, national and international markets and explore the concept of shared- and co-operative branding.
- promote the importance of brand valuation and measurement techniques within their company.
- form and apply tactics to address brand falsification and protection as well as to develop strategies to manage a brand crisis.
- analyze the main challenges facing international brands, and be able to measure their brand equity
- understand the factors that contribute to increasing or losing consumer-based brand equity.
- analyze a company's current brand strategy and propose viable alternatives as well as make informed decisions with greater probability of success.

Contents

1. Introduction to Global Brand Management
   - 1.1 Brand, Brand Equity, and Brand Value
   - 1.2 Brand Management and Brand Leadership
   - 1.3 Integrating Marketing Activities

2. Culture and Branding
   - 2.1 What is Culture?
   - 2.2 Culture and Consumer Behavior
   - 2.3 The Global-Local Dilemma of Branding

3. Creating Global Brands
   - 3.1 Brand Positioning
   - 3.2 Designing and Implementing Stages of Branding Strategies
   - 3.3 Choosing Brand Elements to Build Brand Equity
   - 3.4 Designing Marketing Programs to Build Brand Equity

4. Managing Global Brands
   - 4.1 Branding Strategy
   - 4.2 Brand Hierarchy
   - 4.3 Business-to-Business (B2B) Brand Management Strategies

5. Growing and Sustaining Brand Equity
   - 5.1 Extending the Brand
   - 5.2 Brand Alliances
   - 5.3 Green and Cause Marketing

6. Measuring Global Brand Equity and Performance
   - 6.1 Brand Equity Measurement Systems
   - 6.2 Measuring Sources of Brand Equity
   - 6.3 Measuring Outcomes of Brand Equity

7. Brand Analysis and Strategy Across Multiple Markets: A Managerial Approach
   - 7.1 Internal Analysis
   - 7.2 External Analysis
   - 7.3 Global Brand Management Scenarios

8. Managing a Brand Crisis
   - 8.1 Revitalizing a Brand
   - 8.2 Brand Falsification
   - 8.3 Brand Protection Strategies
   - 8.4 Brand Crises

Literature

Compulsory Reading

Further Reading

- Aaker, D. A. (1991). Managing brand equity. New York, NY: Free Press.
- de Mooij, M. (2014). Global marketing and advertising: Understanding cultural paradoxes (4th ed.). Thousand Oaks, CA: Sage.
- Kapferer, J. N. (2012). The new strategic brand management: Advanced insights and strategic thinking (5th ed.). London: Kogan Page.
- Keller, K. L., Aperia, T., & Georgson, M. (2013). Strategic brand management: A European perspective (2nd ed.). Upper Saddle River, NJ: Prentice Hall. (Database: MyiLibrary).

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☑ Vodcast	☐ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Sales and Pricing

Course Code: DLMBSPBE02

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

Course Description

Establishing and maintaining a competitive customer interface is one of the major challenges for every company to assure successful revenue- and profit-management.The course will allow students to understanding the optimization levers of the customer interface. This includes advanced methods of market- and customer segmentation, channel management including the design, setup and optimization of a customer oriented sales organization (e.g. key account management), practices for sales-force-effectiveness, sales optimization levers, e.g. for customer penetration, and methods for price-differentiation and -realization.The course incorporates case-studies and practice related data and for each optimization lever, students are introduced to a comprehensive tool-box approach. The tool box for each lever contains the required theory, a set of basic analyses and the application of best-practice examples and metrics.

Course Outcomes

On successful completion, students will be able to

- identify the key-success factors for modern sales organizations.
- describe the relationship between segmentation and the design of an appropriate sales organization.
- execute respective analyses and apply improvement levers.
- demonstrate the use of the tool-boxes for the respective optimization levers.
- identify major characteristics of a high-performance sales organization.
- conduct decisive analyses to assess the strength and weaknesses of a sales organization and identify respective optimization levers.
- implement the required organizational and process-related improvement levers.
- measure the performance of a sales-organization using established methods, KPIs and metrics.
- apply fundamental concepts of international pricing.

Contents

1. Segmentation
   - 1.1 Customer Segmentation
   - 1.2 Selection of Market Segments for Market Entry
   - 1.3 Development of Market Segments

2. Channel Management
   - 2.1 Distribution System as a Function of the Products Sold
   - 2.2 Selection of Distribution Partners
   - 2.3 Professionalization and Mobilization of Distribution Partners
   - 2.4 Control of Distribution Partners

3. Sales Force Effectiveness
   - 3.1 Sales Strategy
   - 3.2 Sales Process
   - 3.3 Sales Organization
   - 3.4 Sales Information and Management Systems
   - 3.5 Sales Controlling

4. Sales Optimization Levers
   - 4.1 Key Account Management
   - 4.2 Proactive Sales
   - 4.3 Value-Based Selling
   - 4.4 Online Sales Tools

5. Fundamentals of International Pricing
   - 5.1 Pricing Strategies
   - 5.2 Pricing for Market Segments
   - 5.3 Transaction Pricing and Managing the Price Waterfall
   - 5.4 Price Differentiation and Standardization in an International Context

6. Special Topics in International Pricing
   - 6.1 Gray Markets
   - 6.2 Transfer Pricing
   - 6.3 Price Wars
   - 6.4 Innovative Pricing Methods
   - 6.5 Risks in International Business

Literature

Compulsory Reading

Further Reading

- Dibb, S., & Simkin, L. (2010). The market segmentation workbook: Target marketing for marketing managers. Boston, MA: Cengage Learning.
- Kotler, P., Keller, K., Brady, M., Goodman, M., & Hansen, T. (2016). Marketing management (3rd ed.) (pp. 331–420). Harlow: Pearson Education. (Database: Myilibrary).
- Nagle, T. T., Zale, J., & Hogan, J. (2016). The strategy and tactics of pricing (5th ed.). Abingdon: Routledge. (Database: EBSCO).
- Zoltners, A. A., Sinha, P., & Zoltners, G. A. (2001). The complete guide to accelerating sales force performance: How to get more sales from your sales force. New York, NY: Amacom. (Database: EBSCO).

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Consumer Behavior and Research

Module Code: DLMBCBR

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	10	300 h

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

Module Coordinator

Caterina Fox (International Consumer Behavior) / Caterina Fox (Applied Marketing Research)

Contributing Courses to Module

- International Consumer Behavior (DLMBCBR01)
- Applied Marketing Research (DLMBCBR02)

Module Exam Type

Module Exam	Split Exam
	International Consumer Behavior • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes Applied Marketing Research • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

International Consumer Behavior

- Consumer Behavior
- The Consumer Decision-Making Process
- Internal Influences on Consumer Behavior
- External Influences on Consumer Behavior
- International Consumer Behavior
- International Marketing Strategy and Consumer Behavior

Applied Marketing Research

- The Role of Marketing Research in Managerial Decision-Making
- Problem Definition and the Marketing Research Process
- Secondary Data and Qualitative Research
- Survey Research and the Concept of Measurement
- Observational Research
- Sampling Issues, Data Processing, and Fundamental Data Analysis
- Communicating the Research Results

Learning Outcomes

International Consumer Behavior

On successful completion, students will be able to

- outline the purchase decision-making process undertaken by the consumer.
- describe the internal and external influences on the consumer decision-making processes.
- identify the different research methods available to companies to collect relevant data regarding their consumers and their behavior
- develop a plan to generate required market research data regarding consumer behavior and decision-making.
- be able to generate, analyze, interpret and report relevant data regarding consumers.
- present the key concepts characterizing international consumer behavior and discuss their impact on global marketing strategies.

Applied Marketing Research

On successful completion, students will be able to

- recognize and promote the importance of marketing research methodologies in supporting key marketing management decisions.
- identify some of the challenges of marketing research in an international environment.
- identify appropriate analysis tools for a given marketing related problem on a strategic and operational level.
- identify errors made in the research process.
- outline the stages of the marketing research process.
- identify ethical problems in a marketing research situation and propose an ethically sound approach.
- propose a research design to study a particular research question.
- compare and contrast different research methods.
- recommend good practice for a variety of research techniques.
- design questionnaires with sound measurement properties.
- interpret results of advanced marketing research efforts.
- transfer the gained insights into their future international work environment.

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(s) Marketing & Sales	All Master Programmes in the Marketing field(s)

International Consumer Behavior

Course Code: DLMBCBR01

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

Course Description

In a global economy characterized by greater competition, companies operating internationally need comprehensive market-driven strategies to survive in the market place. The course provides students with the relevant concepts for understanding the international environment of the company with focus on the demand side/the consumer. Students learn how differences in culture, economic systems, and political environments impact consumers' behavior in terms of decision-making in the fields of acquisition, consumption, and disposal of products, services, experiences, and ideas.

Course Outcomes

On successful completion, students will be able to

- outline the purchase decision-making process undertaken by the consumer.
- describe the internal and external influences on the consumer decision-making processes.
- identify the different research methods available to companies to collect relevant data regarding their consumers and their behavior
- develop a plan to generate required market research data regarding consumer behavior and decision-making.
- be able to generate, analyze, interpret and report relevant data regarding consumers.
- present the key concepts characterizing international consumer behavior and discuss their impact on global marketing strategies.

Contents

1. Consumer Behavior
   - 1.1 Consumer Behavior and International Marketing
   - 1.2 Consumer Decision-Making in the Marketplace
2. The Consumer Decision-Making Process
   - 2.1 The Pre-Purchase Stage
   - 2.2 The Purchase Stage
   - 2.3 The Post-Purchase Stage

3. Internal Influences on Consumer Behavior
   - 3.1 Motives and Motivation
   - 3.2 Perception
   - 3.3 Attitude

4. External Influences on Consumer Behavior
   - 4.1 Culture
   - 4.2 Subculture
   - 4.3 Groups and Families

5. International Consumer Behavior
   - 5.1 Cultural Dimensions
   - 5.2 The Influence of Social Media on Consumer Decision-Making

6. International Marketing Strategy and Consumer Behavior
   - 6.1 International Market Segmentation and Product Positioning
   - 6.2 Consumer Behavior and Product Strategy
   - 6.3 Consumer Behavior and Communication Strategy
   - 6.4 Consumer Behavior and Pricing Strategy
   - 6.5 Consumer Behavior and Distribution Strategy

Literature

Compulsory Reading

Further Reading

- Schiffman, L. G., & Kanuk, L. L. (2014). Consumer behavior. Frenchs Forest.: Pearson Education Australia.
- Solomon, M. (2016). Consumer behavior: Buying, having, and being (12th ed.). New York City, NY: Pearson.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Applied Marketing Research

Course Code: DLMBCBR02

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

Course Description

In a global economy characterized by greater competition, companies operating internationally need comprehensive market-driven strategies in order to survive in the market place. The course allows students to explore marketing research, the information-gathering arm of marketing practice. The topic is viewed primarily from the perspective of a consumer of marketing research, i.e. a busy manager who needs information to guide decision making. Given their role in decision-making regarding marketing and sourcing marketing research, it is helpful for managers to understand how producers of research approach the process. This background will help you as a manager to become a better-informed consumer of research who is able to participate in research design, evaluate the quality of marketing information that crosses your desk, and conduct marketing research projects yourself when appropriate.

Course Outcomes

On successful completion, students will be able to

- recognize and promote the importance of marketing research methodologies in supporting key marketing management decisions.
- identify some of the challenges of marketing research in an international environment.
- identify appropriate analysis tools for a given marketing related problem on a strategic and operational level.
- identify errors made in the research process.
- outline the stages of the marketing research process.
- identify ethical problems in a marketing research situation and propose an ethically sound approach.
- propose a research design to study a particular research question.
- compare and contrast different research methods.
- recommend good practice for a variety of research techniques.
- design questionnaires with sound measurement properties.
- interpret results of advanced marketing research efforts.
- transfer the gained insights into their future international work environment.

Contents

1. The Role of Marketing Research in Managerial Decision-Making
   - 1.1 The Importance of Marketing Research in Decision-Making
   - 1.2 The Institutions Involved in Marketing Research
   - 1.3 Common Challenges in Conducting Marketing Research

2. Problem Definition and the Marketing Research Process
   - 2.1 From Problem Recognition to Research Objectives: Step One
   - 2.2 From Research Design to Follow-Up: Steps Two to Six
   - 2.3 Forward and Backward Linkages in the Marketing Research Process

3. Secondary Data and Qualitative Research
   - 3.1 Advantages and Limitations of Secondary Data
   - 3.2 Definition and Types of Qualitative Research
   - 3.3 Limitations of Qualitative Research

4. Survey Research and the Concept of Measurement
   - 4.1 Survey Errors and Their Impact on Research Outcomes
   - 4.2 Measurement Scales
   - 4.3 Questionnaire Design

5. Observational Research
   - 5.1 Observational Research Defined
   - 5.2 Approaches to Observational Research
   - 5.3 Advantages and Limitations of Observational Research

6. Sampling Issues, Data Processing, and Fundamental Data Analysis
   - 6.1 Sampling Methods and Types of Samples
   - 6.2 Data Processing Issues
   - 6.3 Fundamental Data Analysis

7. Communicating the Research Results
   - 7.1 The Major Steps in Communicating the Results
   - 7.2 Organization of the Research Report
   - 7.3 The Marketing Research Presentation

Literature
Compulsory Reading
Further Reading ' Aaker, D. A., Kumar, V., Leone, R., & Day, G. S. (2012). Marketing Research (11th ed.). Hoboken, NJ: John Wiley & Sons. ' Grover, R., & Vriens, M. (2006). The Handbook of Marketing Research: Uses, Misuses, and Future Advances. Thousand Oaks, CA: Sage Publications. ' Iacobucci, D., & Churchill, G. A. (2015). Marketing Research: Methodological Foundations (11th ed.). Mason, OH: South-Western Thomson Learning. ' Malhotra, N. K., Birks, D. F., & Wills, P. A. (2012). Marketing Research: An Applied Approach (4th ed.). Harlow: Pearson.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Corporate Finance

Module Code: DLMBCF

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	None	MBA MA	10	300 h

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

Module Coordinator

Prof. Dr. David Florysiak (Corporate Finance) / Prof. Dr. Andreas Simon (Advanced Corporate Finance)

Contributing Courses to Module

- Corporate Finance (DLMINRE01)
- Advanced Corporate Finance (DLMBCFIE01)

Module Exam Type

Module Exam	Split Exam
	Corporate Finance • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes Advanced Corporate Finance • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

Corporate Finance

- Portfolio and capital market theory and analysis
- Financing types, capital structure, and capital budgeting
- Company valuation procedures
- Acquisitions, corporate control and governance
- Finance planning
- Financing decisions and issuing securities
- Dividend policy and capital structure
- Debt financing and leasing
- Options and futures
- Takeovers, corporate control, and governance
- Solved and unsolved issues and the future of finance

Advanced Corporate Finance

Learning Outcomes

Corporate Finance

On successful completion, students will be able to

- know the key components of corporate finance.
- use financial mathematical methods.
- apply the previously learned methods by using selected data sets and case studies.
- understand the capital structures of a corporation as well as their need to make investment and funding decisions.
- apply the common methods of business valuation and understand the basics of mergers & acquisitions.

Advanced Corporate Finance

On successful completion, students will be able to

- identify methods of issuing corporate debt and equity securities, and understand the role of financial intermediaries.
- discuss dividend policy and corporate capital structure in perfect markets vis-à-vis imperfect markets.
- utilize a range of tools for valuing different kinds of debt.
- describe various financing options and their different forms of application in the context of corporate finance.
- discuss mergers and takeovers and the role of different parties involved in the transaction process.

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 Finance & Tax Accounting	All Master Programmes in the Business & Management fields

Corporate Finance

Course Code: DLMINRE01

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

Course Description

How is funding provided to a corporate activity? How much loan capital and/or own capital does one need? Which projects are worth investing in? What is the actual value of a company? What instruments are available to measure the value of a company and assess financial markets? How can one ensure an optimal balance between the competing goals of liquidity, safety, yield, and growth?This course offers answers to these and other complex questions on the topic of financing and investing. The introduction deals with portfolio selection and capital market theory. With this theoretical foundation, various financing types and capital structures are then explained in detail. Well-known corporate assessment procedures, such as the discounted cash flow method, are presented, as are different calculations that can be used to inform decision making. A critical element of the course is the topic of mergers and acquisitions. Case studies are included to illustrate which parties are typically involved in a merger or acquisition and what criteria is used to determine the success of such a venture. The course concludes with the topic of finance planning.

Course Outcomes

On successful completion, students will be able to

- know the key components of corporate finance.
- use financial mathematical methods.
- apply the previously learned methods by using selected data sets and case studies.
- understand the capital structures of a corporation as well as their need to make investment and funding decisions.
- apply the common methods of business valuation and understand the basics of mergers & acquisitions.

Contents

1. Portfolio and Capital Market Theory
   - 1.1 Capital Markets and Informational Efficiency
   - 1.2 Portfolio Theory
   - 1.3 CAPM

2. Stock and Portfolio Analysis
   - 2.1 Measures of Risk and Performance
   - 2.2 Stock Analysis

3. Optimal Capital Structure
   - 3.1 Capital Structure Based on the Traditional Theorem
   - 3.2 Capital Structure According to Modigliani/Miller
   - 3.3 Neo-Institutional Capital Structure Model

4. Types of Financing
   - 4.1 Internal and External Financing
   - 4.2 Debt Financing
   - 4.3 Equity Financing
   - 4.4 Additional Financing Options

5. Capital Budgeting
   - 5.1 Fundamental Concepts
   - 5.2 Static Capital Budgeting Methods
   - 5.3 Dynamic Investment Calculation Methods

6. Business Valuation
   - 6.1 Purpose and Methods of Business Valuation
   - 6.2 Individual Valuation Methods
   - 6.3 Total Valuation Methods
   - 6.4 Weighted Average Cost of Capital (WACC)

7. Corporate Control and M&A
   - 7.1 The Market for Corporate Control: Mergers and Acquisitions
   - 7.2 Motivations for M&A Transactions
   - 7.3 Phases of M&A Transactions

8. Specific Forms of M&A, Private Equity, Due Diligence, and IPOs
   - 8.1 Due Diligence
   - 8.2 Friendly and Hostile Takeovers, LBOs, MBOs, and MBIs, and IPOs
   - 8.3 Private Equity & Venture Capital Companies

9. Corporate Governance
   - 9.1 Internal and External Corporate Governance
   - 9.2 Example of Legal Basis: Sarbanes Oxley Act (SOX)
   - 9.3 Effect on the Company Performance and the Significance of Ownership Structures
   - 9.4 Additional Financing Options

10. Financial Planning
   - 10.1 Principles of Financial Planning
   - 10.2 Cash Budgeting
   - 10.3 Projected Financial Statements and Ratios

Literature

Compulsory Reading

Further Reading

- Brealey, R., Myers, S. C., & Allen, F. (2016). Principles of corporate finance (12th ed.). New York, NY: McGraw-Hill Education.
- Brealey, R. A., Myers, S. C., & Marcus, A. J. (2015). Fundamentals of corporate finance (8th ed.). New York, NY: McGraw-Hill Education.
- Brigham, E. F., & Daves, P. R. (2016). Intermediate financial management (12th ed.). Boston, MA: Cengage.
- Copeland, T. E., Weston, J. F., & Shastri, K. (2014). Financial theory and corporate policy (Pearson New International ed.). Harlow: Pearson Education.
- Damodaran, A. (2014). Applied corporate finance (4th ed.). Hoboken, NJ: Wiley & Sons.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Advanced Corporate Finance

Course Code: DLMBCFIE01

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

Course Description

The last decade has seen fundamental changes in financial markets and financial instruments. Both the theory and practice of corporate finance have been moving ahead with uncommon speed. Participants will be guided through the main areas of modern financial theory, including the pricing of assets and derivatives, corporate financial policy, and corporate control. The course emphasizes the modern fundamentals of the theory of finance and brings the theory to life with contemporary examples.

Course Outcomes

On successful completion, students will be able to

- identify methods of issuing corporate debt and equity securities, and understand the role of financial intermediaries.
- discuss dividend policy and corporate capital structure in perfect markets vis-à-vis imperfect markets.
- utilize a range of tools for valuing different kinds of debt.
- describe various financing options and their different forms of application in the context of corporate finance.
- discuss mergers and takeovers and the role of different parties involved in the transaction process.

Contents

1. Financing Decisions and Issuing Securities
   - 1.1 Types of Corporate Financing
   - 1.2 Corporations and Issuing Shares
   - 1.3 Corporations and Issuing Debt Securities
2. Dividend Policy and Capital Structure
   - 2.1 What's Your Dividend Policy?
   - 2.2 What's Your Debt Policy?
   - 2.3 Weighted Average Cost of Capital (WACC)
   - 2.4 Corporate and Personal Taxes
   - 2.5 Capital Structure and Related Theories

3. Debt Financing and Leasing
   - 3.1 Debt Valuation
   - 3.2 Rating Debt
   - 3.3 Different Kinds of Debt and Hybrid Securities
   - 3.4 Leasing as a Form of Corporate Finance

4. Options and Futures
   - 4.1 Derivative Financial Instruments, Options and Futures
   - 4.2 Valuing Options, the Binomial Model, the Black-Scholes Formula
   - 4.3 Real Options

5. Takeovers, Corporate Control, and Governance
   - 5.1 Mergers and Acquisitions
   - 5.2 LBOs, Management Buyouts, and Going Private
   - 5.3 Private Equity and the Venture Capitalist
   - 5.4 Empirical Testing of Takeover Success
   - 5.5 Corporate Governance and Corporate Control

6. Unsolved Issues and the Future of Finance
   - 6.1 What Do We Know and What Do We Not Know About Finance?
   - 6.2 The Future of Finance

Literature

Compulsory Reading

Further Reading

- Brealey, R., Myers, S. C., & Allen, F. (2016). Principles of corporate finance (12th ed.). New York, NY: McGraw-Hill Education.
- Vernimmen, P., Quiry, P., Dallocchio, M., Le Fur, Y., & Salvi, A. (2014). Corporate finance: Theory and practice (4th ed.). Hoboken, NJ: John Wiley & Sons. (Database: EBSCO).

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Innovate and Change

Module Code: DLMDSEIAC-01

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	10	300 h

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

Module Coordinator

Prof. Dr. Magdalena Bathen-Gabriel (Change Management) / Prof. Dr. Georg Berkel (Innovation and Entrepreneurship)

Contributing Courses to Module

- Change Management (DLMBCM01)
- Innovation and Entrepreneurship (DLMBIE01-01)

Module Exam Type

Module Exam	Split Exam
	Change Management • Study Format "Distance Learning": Written Assessment: Case Study Innovation and Entrepreneurship • Study Format "myStudies": Exam, 90 Minutes • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

Change Management

- The context and meaning of change
- The change process
- Perspectives for understanding change
- Implementing change

Innovation and Entrepreneurship

- Innovation management and entrepreneurship in a globalized world
- Basics of entrepreneurship
- Business ideas and company foundations
- Financing sources and processes
- Internet, digital business, and artificial intelligence
- Strategic alliances
- Family-owned companies

Learning Outcomes

Change Management

On successful completion, students will be able to

- recognize common features of organizational change and anticipate some of the standard difficulties encountered when an organization engages in change processes.
- explain the importance of organizational change.
- develop a conceptual framework for planned and improvised organizational change, and differentiate between anticipated, emergent, and opportunity-based change.
- utilize and redesign formal organizational structures to facilitate change processes.
- recognize the role of informal organizational structures and identify key stakeholders to promote change processes.
- analyze the social networks that exist within an organization, map independencies and motives/interests, and plan how to distribute information and redesign work flows.
- differentiate between groups of stakeholders and identify the most suitable strategy to adopt with each group.
- recognize the role of the change leader as a political broker and build social capital through informal methods.
- utilize stories and symbols when communicating with others in an organization to maximize leverage as a cultural change leader.
- draw on empirical evidence to plan and implement change processes in an organization.

Innovation and Entrepreneurship

On successful completion, students will be able to

- understand the importance, fundamentals, and dimensions of entrepreneurship and its derivatives (intrapreneurship, corporate entrepreneurship, stakeholder relationships, and family businesses).
- analyze the opportunities and challenges associated with evaluating a business idea and setting up a business.
- distinguish between the different motivations behind entrepreneurial activity and develop specific objectives for new enterprises.
- develop a business model, including benchmarks for assessing desired sustainable growth.
- apply different legal forms to business start-ups and select the appropriate legal form for a specific business model.
- understand the different ways in which entrepreneurship and innovation can be financed and weigh them against each other in terms of medium- and long-term advantages and disadvantages.
- develop a rigorous business plan that can be used both as a planning and financing instrument.
- apply, in principle, an entrepreneurial mindset in a variety of different contexts of future professional development.

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 Business Administration & Management	All Master Programmes in the Business & Management fields

Change Management

Course Code: DLMBCM01

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

Course Description

We live in a world characterized by constant change. This affects not only individuals but also organizations. Even successful organizations need to constantly reinvent themselves in order to remain successful. This course presents a discussion of change in relation to the complexities of organizational life, with an emphasis on applying theory to actual practice. Organizational change is an international phenomenon and the course includes many international case examples. With a focus on organizational change as opposed to personal change and/or entrepreneurship, this course has a distinctly different focus from the related modules “Leadership” and “Innovation and Entrepreneurship.” The first part of the course considers the nature of change and different change models. The second part focuses on how different perspectives complement one another and can be used to better understand, analyze, and diagnose change processes. The course deals with issues of structure, culture, and politics. In the later part of the course, the implementation of change is considered in detail. Given that many change processes fail, this part is an important learning component to complement an in-depth understanding of change.

Course Outcomes

On successful completion, students will be able to

- recognize common features of organizational change and anticipate some of the standard difficulties encountered when an organization engages in change processes.
- explain the importance of organizational change.
- develop a conceptual framework for planned and improvised organizational change, and differentiate between anticipated, emergent, and opportunity-based change.
- utilize and redesign formal organizational structures to facilitate change processes.
- recognize the role of informal organizational structures and identify key stakeholders to promote change processes.
- analyze the social networks that exist within an organization, map independencies and motives/interests, and plan how to distribute information and redesign work flows.
- differentiate between groups of stakeholders and identify the most suitable strategy to adopt with each group.
- recognize the role of the change leader as a political broker and build social capital through informal methods.
- utilize stories and symbols when communicating with others in an organization to maximize leverage as a cultural change leader.
- draw on empirical evidence to plan and implement change processes in an organization.

Contents

1. Organizational Change
   - 1.1 What is Organizational Change About?
   - 1.2 Organizational Change is Ubiquitous
   - 1.3 Change is Difficult

2. Change Management
   - 2.1 The Context of Organizational Change
   - 2.2 Planned Versus Improvisational Change Management
   - 2.3 The Congruence Model of Change

3. Designing Structure
   - 3.1 Formal Structure in Organizations
   - 3.2 Grouping
   - 3.3 Linking
   - 3.4 The Change Leader as an Architect

4. Social Networks
   - 4.1 What are Social Networks?
   - 4.2 Key Terms of Social Network Analysis
   - 4.3 Unique Characteristics of Social Networks
   - 4.4 Social Networks and Organizational Change

5. Politics
   - 5.1 Organizations as Political Arena
   - 5.2 Politics and Change
   - 5.3 The Importance of a Political Perspective on Change

6. Sense-Making
   - 6.1 Organizational Culture
   - 6.2 Sense-Making in Organizations
   - 6.3 The Change Leader as Shaman

7. Change Implementation
   - 7.1 How to Implement Change Successfully
   - 7.2 Four Perspectives on Change

Literature
Compulsory Reading
Further Reading ' Bolman, L. G., & Deal, T. E. (2013). Reframing organizations: Artistry, choice, and leadership (5th ed.). San Francisco, CA: Jossey-Bass. ' Cameron, K. S., & Quinn, R. E. (2011). Diagnosing and changing organizational culture: Based on the competing values framework (3rd ed.). San Francisco, CA: Jossey-Bass. ' Pentland, A. (2014). Social physics: How good ideas spread – The lessons from a new science. New York, NY: Penguin Press. ' McChrystal, S., Collins, T., Silverman, D., & Fussell, C. (2015). Team of teams: New rules of engagement for a complex world. New York, NY: Penguin Press. ' Worren, N. A. M. (2012). Organisation design: Re-defining complex systems. Harlow: Pearson.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Innovation and Entrepreneurship

Course Code: DLMBIE01-01

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

Course Description

In today's globalized and digital world, entrepreneurs have more opportunities to develop and market products and services than ever before. However, entrepreneurship, whether in the form of entrepreneurship or intrapreneurship, presents special challenges. In order to avoid the typical pitfalls of starting and growing a business, a sound understanding of innovation management and building a business is essential. Particular attention must be paid to the financing of entrepreneurial activity, both from the perspective of the entrepreneur and the investor. Innovation and entrepreneurial activity are the basis and driving force of our economy. Even looking at other economies, it is obvious that innovation and entrepreneurship are crucial at every stage of economic development. Small enterprises in developing countries initiate the development of economic institutions and create supply, demand, and markets. These enterprises lay the foundation for economic development and growth. In developed economies, innovation and entrepreneurship are the driving forces behind competition and competitiveness in the global context. In all parts of the world, family businesses play the most important role. The rapid technological and social change present in our societies requires the innovative use of digital technologies (internet and artificial intelligence), as well as flexibility in handling new forms of organization (e.g., strategic alliances between companies). This course introduces students to the ideas behind, motives, and drivers of entrepreneurial activity and innovation and teaches them the practical aspects of the identification, analysis, and development of innovations and business ideas. The core competence of the entrepreneur—the ability to negotiate with investors and partners—is also addressed.

Course Outcomes

On successful completion, students will be able to

- understand the importance, fundamentals, and dimensions of entrepreneurship and its derivatives (intrapreneurship, corporate entrepreneurship, stakeholder relationships, and family businesses).
- analyze the opportunities and challenges associated with evaluating a business idea and setting up a business.
- distinguish between the different motivations behind entrepreneurial activity and develop specific objectives for new enterprises.
- develop a business model, including benchmarks for assessing desired sustainable growth.
- apply different legal forms to business start-ups and select the appropriate legal form for a specific business model.
- understand the different ways in which entrepreneurship and innovation can be financed and weigh them against each other in terms of medium- and long-term advantages and disadvantages.
- develop a rigorous business plan that can be used both as a planning and financing instrument.
- apply, in principle, an entrepreneurial mindset in a variety of different contexts of future professional development.

Contents

1. Entrepreneurship
   - 1.1 Entrepreneurship and entrepreneur
   - 1.2 Enterprise related theories of entrepreneurship
   - 1.3 The economic significance of entrepreneurship
2. Company formation strategy
   - 2.1 Different contexts in which companies are founded
   - 2.2 The Entrepreneur
   - 2.3 Business models and strategies
3. Innovation and innovation management
   - 3.1 Innovation
   - 3.2 Innovation management
   - 3.3 Protection of intellectual property
   - 3.4 Case study: BMW Empathic Design
4. Legal form in international comparison
   - 4.1 Germany
   - 4.2 International comparison: USA

5. Financing entrepreneurial activity I: Sources of finance
- 5.1 Incubators, accelerators and crowdfunding
- 5.2 Business angels
- 5.3 Private equity and corporate venture capital
- 5.4 Public start-up support

6. Financing entrepreneurial activity II: Financing processes
- 6.1 The investor view: Deal sourcing and deal screening
- 6.2 The entrepreneurial view: Negotiations with investors
- 6.3 The evaluation of business start-ups

7. The business plan
- 7.1 Purpose and objectives of the business plan
- 7.2 Expectations regarding the business plan
- 7.3 Structure and content of the business plan
- 7.4 Guidelines for creating a business plan

8. Digital business models and artificial intelligence
- 8.1 e-Business
- 8.2 Artificial intelligence
- 8.3 The Globotics Evolution

9. Cooperative strategy: Alliances and joint ventures
- 9.1 Cooperative strategy
- 9.2 The right “fit”
- 9.3 The right “form”

10. Family-owned company
- 10.1 Definitions
- 10.2 Economic significance
- 10.3 Strengths and weaknesses

Literature
Compulsory Reading
Further Reading ' Mariotti, S., & Glackin, C. (2016). Entrepreneurship: Starting & operating a small business (4th ed.). Pearson. ' Parker, S. C. (2009). The economics of entrepreneurship (pp. 1–28). Cambridge University Press. ' Scarborough, N. M., & Cornwall, J. R. (2019). Essentials of entrepreneurship and small business management (9th ed.). Pearson.

Study Format myStudies

Study Format	Course Type
myStudies	Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☑ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Advanced Robotics 4.0

Module Code: DLMAIEAR

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMAIEAR01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Leonardo Riccardi (Industrial and Mobile Robots) / Prof. Dr. Leonardo Riccardi (Project: Collaborative Robotics)

Contributing Courses to Module

- Industrial and Mobile Robots (DLMAIEAR01)
- Project: Collaborative Robotics (DLMAIEAR02)

Module Exam Type

Module Exam	Split Exam
	Industrial and Mobile Robots • Study Format "Distance Learning": Exam, 90 Minutes Project: Collaborative Robotics • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents

Industrial and Mobile Robots

- Architectural components of mobile and industrial robots
- Mathematical description
- Design of interactions and control

Project: Collaborative Robotics

- Human-robot interaction
- Safety operation
- Human-friendly robot design

A current list of topics is located in the Learning Management System.

Learning Outcomes

Industrial and Mobile Robots

On successful completion, students will be able to

- identify the main challenges of robotics in the era of Industry 4.0.
- understand the working principles of industrial and mobile robots.
- model a robotic system and design a motion control algorithm.
- use software platforms to command the execution of tasks and retrieve the execution status.

Project: Collaborative Robotics

On successful completion, students will be able to

- classify interactions between robots and humans.
- identify safety and risk scenarios.
- understand the principles of human-friendly robot design.
- apply algorithms for safe interaction.

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 Engineering.	All Master Programs in the IT & Technology field.

Industrial and Mobile Robots

Course Code: DLMAIEAR01

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

Course Description

The focus of this course is the theoretical foundation of mobile and industrial robotics. First, the basic concepts, architectural components (e.g., actuators and sensors), and challenges related to mobile and industrial robotics in the era of Industry 4.0 are presented. Next, the mathematical aspects concerning robot kinematics and trajectory planning are considered. These are necessary in order to define the operative task that a robot (mobile or industrial) must execute. The dynamics of a robotic system provides a mathematical model of the robot which can be exploited for simulation, design, and to control the task execution. There are various control architectures and approaches for robotic systems. This course focuses on the centralized and de-centralized architectures, as well as simple control design (e.g., proportional-integral-derivative control approaches).Finally, this course introduces the main software platforms and architectures used to control and exchange data with robots in a multi-agent environment, for instance, a manufacturing facility where many robots execute different tasks or must cooperate. The main patterns of such architectures and their uses are discussed. The adoption of model-based sensing/perception and control approaches yields intelligent systems which interact with the environment. This course concludes with an overview of behavior-based robotics, where robots are able to dynamically react to and learn from the real world.

Course Outcomes

On successful completion, students will be able to

- identify the main challenges of robotics in the era of Industry 4.0.
- understand the working principles of industrial and mobile robots.
- model a robotic system and design a motion control algorithm.
- use software platforms to command the execution of tasks and retrieve the execution status.

Contents

1. Introduction
   - 1.1 Robots and manufacturing
   - 1.2 Industrial robots
   - 1.3 Mobile robots
   - 1.4 Actuators for robotics
   - 1.5 Trends in robotics

2. Kinematics
   - 2.1 Position and orientation of a rigid body
   - 2.2 Joint kinematics
   - 2.3 Forward kinematics
   - 2.4 Inverse kinematics
   - 2.5 Differential kinematics
   - 2.6 Kinematics of mobile robots

3. Trajectory Planning
   - 3.1 Basic concepts
   - 3.2 Trajectories in the joints space
   - 3.3 Trajectories in the workspace
   - 3.4 Trajectory planning for mobile robots

4. Sensing and Perception
   - 4.1 Position
   - 4.2 Velocity
   - 4.3 Force
   - 4.4 Distance
   - 4.5 Visual

5. Fundamentals of Robot Dynamics
   - 5.1 Rigid body dynamics
   - 5.2 Lagrange formulation
   - 5.3 Newton formulation
   - 5.4 Direct and inverse dynamics
   - 5.5 Dynamics of mobile robots

6. Control of Robots
   - 6.1 Basic concepts
   - 6.2 Decentralized motion control
   - 6.3 Centralized motion control
   - 6.4 Force control

7. Architecture of Robotic Systems
   - 7.1 Architectural components
   - 7.2 Open Robot Control Software (OROCOS)
   - 7.3 Yet Another Robotic System Platform (YARP)
   - 7.4 Robot Operating System (ROS)
   - 7.5 Behavior-based robotics

Literature

Compulsory Reading

Further Reading

- Ben-Ari, M., & Mondada, F. (2017). Elements of robotics. Springer International Publishing.
- Siciliano, B., Sciavicco, L., Villani, L., & Oriolo, G. (2009). Robotics. Springer.
- Siciliano, B., & Khatib, O. (Eds.). (2016). Springer handbook of robotics (2nd ed.). Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Project: Collaborative Robotics

Course Code: DLMAIEAR02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMAIEAR01

Course Description

A collaborative robot is a robot which is used in collaborative operation, where humans and robots share the same workspace. This course focuses on the basic concepts of collaborative robotics, such as classification of human-robot interaction, definition of safe interaction, soft robotics and human-friendly robot design, and algorithms to guarantee such a safe interaction. The students will receive a hands-on introduction to the topic, with the goal of being able to autonomously design, simulate and test collaborative robotic systems.

Course Outcomes

On successful completion, students will be able to

- classify interactions between robots and humans.
- identify safety and risk scenarios.
- understand the principles of human-friendly robot design.
- apply algorithms for safe interaction.

Contents

- Each participant must create a project report on a topic related to collaborative robotics, focusing on design and/or implementation aspects.

Literature

Compulsory Reading

Further Reading

- Ben-Ari, M., & Mondada, F. (2018). Elements of robotics. Cham: Springer.
- Corke, P. (2017). Robotics, vision and control (2nd ed.). Berlin, Heidelberg: Springer.
- Mihelj, M., Bajd, T., Ude, A., Lenarčič, J., Stanovnik, A., Munih, M., … Šlajpah, S. (2019). Robotics (2nd ed.). Cham: Springer.
- Siciliano, B., & Khatib, O. (Eds.). (2016). Springer handbook of robotics (2nd ed.). Berlin, Heidelberg: Springer.
- Teixeira, J. V. S., Reis, A. M., Mendes, F. B., & Vergara, L. G. L. (2019). Collaborative Robots. In P. Arezes (Ed.), Occupational and environmental safety and health. Studies in systems, decision and control (pp. 791-796). Cham: Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Robo Advisory and AI in FinTech

Module Code: DLMAIERAFT

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIESCM01, DLMAIEFT02, DLMAIERAFT01 ' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIESCM01, DLMAIEFT02	MA	10	300 h

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

Module Coordinator
N.N (Robo Advisory) / N.N (AI in FinTech)

Contributing Courses to Module
' Robo Advisory (DLMAIERAFT01) ' AI in FinTech (DLMAIERAFT02)

Module Exam Type	
Module Exam	**Split Exam** <u>Robo Advisory</u> • Study Format "Distance Learning": Written Assessment: Written Assignment <u>AI in FinTech</u> • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents

Robo Advisory

- Introduction of Robo Advisory
- Types of Robo-Advisors and their Business Models
- Selected Areas of Application
- Principles of Goal-Based Investing
- Robo Economicus and Quantitative Models
- The Future Role of Robo-advisors and Asset Management Industry

AI in FinTech

This course covers topics such as AI in FinTech, AI in Start-ups, use of AI in insurance sector and challenges of AI adoption.

Learning Outcomes

Robo Advisory

On successful completion, students will be able to

- understand the history, drivers and importance of the Robo Advisors.
- recognize different types of Robo Advisors such as hybrid and pure models.
- identify the application of Robo Advisors in non-life insurance, chatbots, stocks and derivative pricing.
- describe principles of goal-based investing and risk tolerance frameworks.
- learn about quantitative approaches in Robo-advisory models.
- critically discuss the future role of Robo-advisors in the asset management industry.
- be familiar with the current regulatory landscape of Robo-advisory in Germany and beyond.

AI in FinTech

On successful completion, students will be able to

- understand the history, drivers and importance of the AI in FinTech industry.
- recognize important players in AI ecosystem including FinTech companies, Machine learning service providers.
- learn about the application of AI in various sectors of the economy including finance, insurance, banking, security and surveillance.
- identify use cases, examples and case studies in areas like investment, customer services, Know Your Customer (KYC) and Anti-money Laundering (ALM).
- critically discuss the challenges of AI adoption, ethics and scalability of FinTech.
- be familiar with the current regulatory landscape of AI.

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.

Robo Advisory

Course Code: DLMAIERAFT01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIESCM01, DLMAIEFT02

Course Description

Machines have been part of human life and no one can imagine a world without machines in every sphere of life. However, their application in the financial services industry in various forms such as Robo Advisors as asset managers has accelerated because of breathless digitalization. It is expected that assets under management by Robo Advisory companies will surpass USD 7 trillion by the end of 2025 as these companies offer better returns, low commission charges and sound risk tolerance strategies compared to incumbent financial institutions. Traditionally, financial advisors have been doing asset allocation which required significant investments in training human capabilities, therefore charging significant amounts of fees against their services. However, the increasing use of digital devices, sophistication in automation, AI and FinTechs has enabled various online platforms to do even more accurate asset allocations in a cost-effective manner. Robo advisors apply algorithms and are designed to minimize behavioral errors and are considered as a useful alternative to traditional investment ways. This course aims to provide students an in-depth understanding of the rise of Robo Advisory companies, different types, their core application areas by exploring various cases and examples. This course provides a discussion about principles of goal-based investing, quantitative models and risks tolerance framework of investors. This course also covers aspects related to the future of Robo Advisory, fraud detection capabilities and the current regulatory landscape in Germany and Europe.

Course Outcomes

On successful completion, students will be able to

- understand the history, drivers and importance of the Robo Advisors.
- recognize different types of Robo Advisors such as hybrid and pure models.
- identify the application of Robo Advisors in non-life insurance, chatbots, stocks and derivative pricing.
- describe principles of goal-based investing and risk tolerance frameworks.
- learn about quantitative approaches in Robo-advisory models.
- critically discuss the future role of Robo-advisors in the asset management industry.
- be familiar with the current regulatory landscape of Robo-advisory in Germany and beyond.

Contents

1. Introduction of Robo Advisory
   - 1.1 Definition of Robo advisors
   - 1.2 Importance of Wealth and Asset Management Sector
   - 1.3 Issues of Traditional Asset Management Sector
   - 1.4 Drivers, History and Rise of Robo-advisory and Current State of Financial Markets

2. Types of Robo-Advisors and their Business Models
   - 2.1 Machine Learning Types and Use in Finance
   - 2.2 Hybrid/Bionic Robo Advisors
   - 2.3 Pure Robo Advisors
   - 2.4 Issues of Supervised vs. Unsupervised
   - 2.5 Case studies such as Charles Schwab, Vanguard, Wealthfront and Betterment

3. Selected Areas of Application
   - 3.1 Non-life Insurance
   - 3.2 Chatbots
   - 3.3 Stock and Derivative Price Predictions
   - 3.4 Automatic Rebalancing of Portfolios
   - 3.5 Tax-loss Harvesting

4. Principles of Goal-Based Investing
   - 4.1 Investors Preferences
   - 4.2 Goal-based Investing Process
   - 4.3 Portfolio Modeling
   - 4.4 Risk Tolerance Framework

5. Robo Economicus and Quantitative Models
   - 5.1 Home Bias
   - 5.2 Behavioral Accounting
   - 5.3 Quantitative Approaches in Robo-Advisory Models
   - 5.4 Risk Targets

6. The Future Role of Robo-advisors and Asset Management Industry
   - 6.1 Future of Digital Advice
   - 6.2 Machine Learning Models in Python
   - 6.3 Frauds in Robo Advisory
   - 6.4 The Regulatory Landscape of Robo-Advisory in Germany and Europe

Literature
Compulsory Reading
Further Reading ' Narang, R. (2009). Inside the black box: the simple truth about quantitative trading. John Wiley & Sons Ltd, New Jersey. ' Peter, S. (2021). Robo-Advisory: investing in the digital age. Palgrave Macmillan, Cham. ' Sironi, P. (2016). FinTech innovation: from Robo-advisors to goal based investing and gamification. John Wiley & Sons Ltd, West Sussex. ' Tatsat, H., Puri, S. and Lookbaugh, B. (2021). Machine learning and data science blueprints for finance: from building trading strategies to Robo-advisors using Python. Oreilly, Boston.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

AI in FinTech

Course Code: DLMAIERAFT02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIESCM01, DLMAIEFT02, DLMAIERAFT01

Course Description

Data lies in the heart of the financial services industry and financial institutions allocate large sums of money on collecting, processing, storing and drawing conclusions which are often misleading due to inconsistency in data sets. However, developments in big data, AI and FinTech space are making it possible to remove issues in data quality to ensure fast, accurate and cost-effective solutions, especially to the insurance, banking and finance industries. AI is revolutionizing various segments of the economy ranging from insurance, automotive, security, surveillance to financial institutions. Big Tech companies are making significant investments in AI and it is anticipated that funding for AI companies will increase tremendously in coming years. The financial world requires great corporate governance standards about FinTechs, AI-driven technology companies and data to avoid scandals that have recently shocked the finance world such as Greensill Capital and Wirecard. This course introduces both theoretical and practical concepts of AI, FinTechs, Machine Learning and Deep Learning and provides discussion on underlying drivers of their emergence and astounding application in the financial world. This course aims to provide students an in-depth understanding of AI application in practice by exploring various use cases and examples. Issues related to AI adoption, regulation, ethics and scalability of FinTech companies will be discussed as well.

Course Outcomes

On successful completion, students will be able to

- understand the history, drivers and importance of the AI in FinTech industry.
- recognize important players in AI ecosystem including FinTech companies, Machine learning service providers.
- learn about the application of AI in various sectors of the economy including finance, insurance, banking, security and surveillance.
- identify use cases, examples and case studies in areas like investment, customer services, Know Your Customer (KYC) and Anti-money Laundering (ALM).
- critically discuss the challenges of AI adoption, ethics and scalability of FinTech.
- be familiar with the current regulatory landscape of AI.

Contents

- The choice of topics can be from industry-relevant developments and trends stemming for example (but are not limited to) theoretical, technical advances as well as regulatory, societal changes or trends. Students are asked to explore in depth the current state of a pre-selected or self-chosen subject, using both academic and non-academic literature sources, press, visual media and e.g. own interviews. This course covers topics such as AI in FinTech, AI in Start-ups, use of AI in insurance sector and challenges of AI adoption.

Literature

Compulsory Reading

Further Reading

- Arjundwadkar, P.Y. (2018) FinTech: the technology driving disruption in the financial services industry. CRC Press (Taylor & Francis Group), London.
- Jones, T.M. (2008). Artificial Intelligence: a systems approach. Infinity Sciences Press LLC, New Delhi.
- Lui, A. and Ryder, N. (2021). FinTech, Artificial Intelligence and the law: regulation and crime prevention. Routledge, London.
- Raynor, J.W. (1999).The international dictionary of Artificial Intelligence. Glenklake Publishing, Chicago.
- Russell, S. (2021). Artificial Intelligence: a modern approach (4th Ed). Pearson, Harlow.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Functional Security and Computer Vision for Autonomous Systems

Module Code: DLMAIEFSCVAS

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	10	300 h

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

Module Coordinator

N.N (Functional Security) / Prof. Dr. Thomas Zöller (Computer Vision for Autonomous Systems)

Contributing Courses to Module

- Functional Security (DLMAIEFSCVAS01)
- Computer Vision for Autonomous Systems (DLMAIEFSCVAS02)

Module Exam Type

Module Exam	Split Exam
	Functional Security • Study Format "Distance Learning": Written Assessment: Written Assignment Computer Vision for Autonomous Systems • Study Format "Distance Learning": Written Assessment: Written Assignment

Weight of Module

see curriculum

Module Contents

Functional Security

- Standards for Functional Security
- Approaches for Design for Functional Security and Safety
- Attacks and Defenses

Computer Vision for Autonomous Systems

- Image Formation and Acquisition
- Sensors for Image Acquisition
- Feature Extraction
- Object Detection and Tracking
- Segmentation

Learning Outcomes

Functional Security

On successful completion, students will be able to

- understand the main issues related to safety and security.
- name diverse standards of safety and security.
- understand standards used in automotive.
- name diverse IT standards.
- apply common approaches to enforce security and safety.
- understand and prevent possible cyber and physical attacks.

Computer Vision for Autonomous Systems

On successful completion, students will be able to

- understand color and light.
- understand image formation.
- name commonly used sensors for image acquisition.
- perform basic image processing operations.
- detect features in an image.
- track objects in images and videos.
- apply commonly used algorithms for segmentation.

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 Computer Science & Software Development and Engineering.	All Master Programs in the IT & Technology field.

Functional Security

Course Code: DLMAIEFSCVAS01

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

Course Description

Functional security and safety must be considered when designing software as well as hardware for several applications, in particular for automotive. This course illustrates the main standards of functional security and functional safety, as well as approaches for enforcing them in design.

Course Outcomes

On successful completion, students will be able to

- understand the main issues related to safety and security.
- name diverse standards of safety and security.
- understand standards used in automotive.
- name diverse IT standards.
- apply common approaches to enforce security and safety.
- understand and prevent possible cyber and physical attacks.

Contents

1. Introduction
   - 1.1 Functional Security
   - 1.2 Automotive Safety
   - 1.3 Relevant Standards (ISO 26262, IEC 61508, ISO 27001, EU directive 2001/95/EG, ISO 25119)
2. Functional Safety Standard ISO 26262
   - 2.1 Introduction
   - 2.2 Automotive Safe Integrity Levels (ASIL)
   - 2.3 Recommended Techniques
3. IT Security Standards
   - 3.1 ISO 27001
   - 3.2 ISO 15408
   - 3.3 ISO 21434
   - 3.4 SAE J3061
   - 3.5 AECQ

4. Approaches
   - 4.1 Safe Failure Fraction (SFF)
   - 4.2 Diagnostic Coverage (DC)
   - 4.3 Hazard Analysis and Risk Assessment (HARA)
   - 4.4 Fault Tree Analysis (FTA)
   - 4.5 Failure Modes, Effects & (Diagnostic, Criticality) Analysis (FME[C,D]A)

5. Attacks and Defenses
   - 5.1 Cyber Attacks
   - 5.2 Physical Attacks
   - 5.3 MISRA C/C++ Guidelines

Literature

Compulsory Reading

Further Reading

- Smith D.J., Simpson K. (2016). The Safety Critical Systems Handbook. (4th ed.) Elsevier
- Smith D.j. (2017). Reliability, Maintainability and Risk (9th ed.) Elsevier
- Rausand, M. (2014). Reliability of Safety-Critical Systems: Theory and Applications Wiley.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Computer Vision for Autonomous Systems

Course Code: DLMAIEFSCVAS02

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

Course Description

One of the main capabilities of an autonomous system, for instance a robot, is the ability to view and recognize objects. Object detection, recognition and tracking are advanced task of a modern computer vision system. This course introduces the fundamentals of computer vision, which rely on the beautiful mathematics of image formation as well as the technology of image acquisition. The images are further processed to extract information. Feature detection, object detection, object tracking and image segmentation are described. A chapter on sensors gives an overview of sensors used for computer vision in contemporary robotics and industry.

Course Outcomes

On successful completion, students will be able to

- understand color and light.
- understand image formation.
- name commonly used sensors for image acquisition.
- perform basic image processing operations.
- detect features in an image.
- track objects in images and videos.
- apply commonly used algorithms for segmentation.

Contents

1. Image Formation & Acquisition
   - 1.1 Light
   - 1.2 Color
   - 1.3 Perspective Camera
   - 1.4 Camera Calibration
   - 1.5 Single and Multiple View Geometry

2. Sensors for Computer Vision
   - 2.1 Camera & Night Vision
   - 2.2 Lidar
   - 2.3 Radar
   - 2.4 Ultrasound
   - 2.5 Trends

3. Image Processing
   - 3.1 Operators
   - 3.2 Filtering and Transforms
   - 3.3 Geometric Transformations

4. Feature Detection
   - 4.1 Points
   - 4.2 Edges
   - 4.3 Lines
   - 4.4 Common Methods

5. Object Detection & Tracking
   - 5.1 Object Representation
   - 5.2 Techniques for Object Detection
   - 5.3 Network Architectures

6. Segmentation
   - 6.1 Stuff and Things
   - 6.2 Semantic Segmentation
   - 6.3 Instance Segmentation
   - 6.4 Segmentation in Videos and Feeds
   - 6.5 MOTS: Multi-Object Tracking & Segmentation

Literature

Compulsory Reading

Further Reading

- Ansari, S. (2020). Building Computer Vision Applications Using Artificial Neural Networks. Apress. https://doi.org/10.1007/978-1-4842-5887-3
- Ayyadevara, V., & Reddy, Y. (2020). Modern Computer Vision with PyTorch. Packt.
- Distante, A., & Distante, C. (2020). Handbook of image processing and computer vision: Volume 1: From energy to image. Springer International Publishing. https://doi.org/10.1007/978-3-030-38148-6
- Gonzalez, R. C., & Woods, R. E. (2017). Digital Image Processing (4th ed.). Pearson.
- Peters, J. F. (2017). Foundations of Computer Vision (Vol. 124). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-52483-2
- Szelinski, R. (2020). Computer Vision: Algorithms and Applications. (2nd ed.). Springer Nature.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

AI and its Application in Demand Forecast and Procurement

Module Code: DLMAIEADFP

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEECMDF01 ' DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01	MA	10	300 h

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

Module Coordinator

N.N. Professur für Artificial Intelligence (Demand Forecast and Inventory Control) / N.N (Artificial Intelligence in Procurement)

Contributing Courses to Module

- Demand Forecast and Inventory Control (DLMAIEECMDF02)
- Artificial Intelligence in Procurement (DLMAIEADFP01)

Module Exam Type

Module Exam	Split Exam Demand Forecast and Inventory Control • Study Format "Distance Learning": Exam or Written Assessment: Case Study, 90 Minutes Artificial Intelligence in Procurement • Study Format "Distance Learning": Written Assessment: Project Report
Weight of Module see curriculum	

Module Contents

Demand Forecast and Inventory Control

- Newsvendor Model
- Traditional Methods of Demand Forecasting
- Data Driven methods of Demand Forecasting
- Inventory Models
- Further Effects

Artificial Intelligence in Procurement

In this course students will gain practical experience in modelling and building independently a running AI model or system to address a specific challenge in the field of procurement.

Learning Outcomes

Demand Forecast and Inventory Control

On successful completion, students will be able to

- understand the concepts of demand forecasting and inventory control.
- evaluate which method is appropriate in a specific application scenario.
- analyze which effects need to be considered in demand forecasting or inventory control models.
- create demand forecasting models using the methods discussed in the course.

Artificial Intelligence in Procurement

On successful completion, students will be able to

- analyze and understand real-world procurement problems.
- define an AI-based approach to address the chosen procurement topic.
- translate the learned AI theories and concepts into a running AI model or system to solve the chosen procurement challenge.
- explain the design choices made in the selection of the employed model or system and its implementation.
- critically evaluate the resulting AI model's or system's value for the chosen topic.

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 Transportation & Logistics.	All Master Programs in the Transport & Logistics field.

Demand Forecast and Inventory Control

Course Code: DLMAIEECMDF02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEECMDF01

Course Description

The course gives a general overview of traditional and modern methods used for demand forecasting and inventory control. Starting from the classic newsvendor model and its extensions, the course covers the fundamental aspects of dealing with uncertain demand, including censored data. The course then covers methods used for demand forecasting, starting with more traditional approaches such as exponential smoothing and ARIMA time-series analysis, as well as state-space models and structural time series-based approaches. Next, data-driven and machine learning based approaches are discussed, including methods that exploit the temporal order of, for example, sales data in the forecast and supervised methods that can be used without. To highlight the challenge in exploiting the auto-correlation, the effects of causal relationships in time-series forecasting, in particular temporal confounding are addressed. Further, methods that avoid demand forecasting altogether such as the “Big Data Newsvendor” and similar approaches are discussed. The course then turns towards inventory models, including, for example, models with review such as (s,S) based models. Finally, the course covers a range of topics that are particularly important for practical applications, such as including customer heterogeneity, or the retirement of old and inclusion of new products in the assortment, as well as discussing how to derive operational KPIs that can be used to monitor the replenishment process in practice.

Course Outcomes

On successful completion, students will be able to

- understand the concepts of demand forecasting and inventory control.
- evaluate which method is appropriate in a specific application scenario.
- analyze which effects need to be considered in demand forecasting or inventory control models.
- create demand forecasting models using the methods discussed in the course.

Contents

1. Newsvendor Model
   - 1.1 Single Period Newsvendor (Classic, Cost Function)
   - 1.2 Demand as a Stochastic Quantity
   - 1.3 Demand Models
   - 1.4 Handling Censored Data
   - 1.5 Extensions
   - 1.6 Multi-Period Newsvendor

2. Traditional Methods of Demand Forecasting
   - 2.1 Exponential Smoothing
   - 2.2 ARIMA
   - 2.3 State Space Models
   - 2.4 (Bayesian) Structural Time Series Models

3. Data Driven Methods for Demand Forecasting
   - 3.1 Recurrent Neural Networks
   - 3.2 Supervised Learning
   - 3.3 Effects of Correlation and Confounding
   - 3.4 Big Data Newsvendor

4. Inventory Models
   - 4.1 Economic Order Quantity
   - 4.2 Inventory Models with Review
   - 4.3 Inventory Models with Service Levels

5. Further Effects
   - 5.1 Customer Heterogeneity
   - 5.2 Finite Product Lifetime
   - 5.3 Minimum Order Quantity
   - 5.4 Delivery Schedules
   - 5.5 Operational KPIs and Inventory Optimization

Literature

Compulsory Reading

Further Reading

- Ban GY, Rudin C (2019) The big data newsvendor: Practical insights from machine learning. Oper Res 67(1):90–108
- Bertsimas D, Kallus N (2020) From predictive to prescriptive analytics. Manag Sci 66(3):1025–1044
- Bica I, Alaa A, Van Der Schaar M (2020) Time series deconfounder: Estimating treatment effects over time in the presence of hidden confounders. In: International Conference on Machine Learning. PMLR, pp 884–895
- Brodersen KH, Gallusser F, Koehler J, Remy N, Scott SL (2015) Inferring causal impact using Bayesian structural time-series models. Ann Appl Stat 9:247–274
- De Gooijer JG, Hyndman RJ (2006) 25 years of time series forecasting. Int J Forecast 22(3):443–473
- Galliher, H. P. , Morse, Philip M., Simond, M. (1959) Dynamics of two classes of continuous-review inventory systems. Operations Research, 7(3):362{384}
- Harris, F. (1990) How many parts to make at once. Operations Research, 38(6):947{950}.
- Hillier, F., Liebermann, G. (2020), ISE Introduction to Operations Research, McGraw-Hill
- Huber J, Müller S, Fleischmann M, Stuckenschmidt H (2019) A data-driven newsvendor problem: From data to decision. Eur J Oper Res 278(3):904–915
- Hyndman R, Koehler AB, Ord JK, Snyder RD (2008) Forecasting with exponential smoothing: the state space approach. Springer Science & Business Media
- Khouj, M (1999) The single-period (news-vendor) problem: literature review and suggestions for future research. Omega 27(5):537–553
- Längkvist M, Karlsson L, Loutfi A (2014) A review of unsupervised feature learning and deep learning for time-series modeling. Pattern Recogn Lett 42:11–24
- Lim B, Arik SO, Loeff N, Pfister T (2019) Temporal fusion transformers for interpretable multi-horizon time series forecasting. arXiv preprint arXiv:1912.09363
- Malinsky D, Spirtes P (2018) Causal structure learning from multivariate time series in settings with unmeasured confounding. In: Proceedings of 2018 ACM SIGKDD Workshop on Causal Discovery, pp 23–47
- Nahmias, S. , Pierskalla, W. (1973) Optimal ordering policies for a product that perishes in two periods subject to stochastic demand. Naval Research Logistics Quarterly, 20(2):207{229, 1973.
- Porteus, E. (1983) Inventory Policies for Periodic Review Systems. Research Papers 650, Stanford University, Graduate School of Business, June 1983.
- Rasul K, Sheikh AS, Schuster I, Bergmann U, Vollgraf R (2020) Multi-variate probabilistic time series forecasting via conditioned normalizing flows. arXiv preprint arXiv:2002.06103
- Runge J (2018) Causal network reconstruction from time series: From theoretical assumptions to practical estimation. Chaos Int J Nonlinear Sci 28(7):075310
- Scarf, H. (1959) Bayes solutions of the statistical inventory problem. Ann. Math. Statist., 30(2):490{508, 06
- Vandeput, N. (2020) Inventory Optimization: Models and Simulations, De Gruyter
- Wick, F. et al. (2021) Demand Forecasting of Individual Probability Density Functions with Machine Learning. SN Oper. Res. Forum 2, 37. https://doi.org/10.1007/s43069-021-00079-8

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam or Written Assessment: Case Study, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
100 h	0 h	25 h	25 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Artificial Intelligence in Procurement

Course Code: DLMAIEADFP01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01

Course Description

The focus of this course is to give students the opportunity to gain practical experience in the design and application of artificial intelligence technologies in the field of procurement. Together with their tutor, the students choose a specific challenge from a variety of procurement task in supply chain management, such as supplier selection, supplier communication, fraud detection or risk analysis. The goal is a prototypical implementation of a model or system of artificial intelligence in a suitable development environment to address the chosen procurement challenge. The choice of approach, the system or software implemented, and the resulting performance of the task must be reasoned out, explained, and documented

Course Outcomes

On successful completion, students will be able to

- analyze and understand real-world procurement problems.
- define an AI-based approach to address the chosen procurement topic.
- translate the learned AI theories and concepts into a running AI model or system to solve the chosen procurement challenge.
- explain the design choices made in the selection of the employed model or system and its implementation.
- critically evaluate the resulting AI model’s or system’s value for the chosen topic.

Contents

- In this course the students work on a practical implementation of an artificial intelligence use case of their choosing in the field of procurement. Students can also contribute their own project ideas related to the field of procurement. All relevant artifacts like use case evaluation, chosen implementation method, code, and outcomes are to be documented.

Literature

Compulsory Reading

Further Reading

- Cavalcante, I. M., Frazzon, E. M., Forcellini, F. A., Ivanov, D. (2019): A supervised machine learning approach to data-driven simulation of resilient supplier selection in digital manufacturing, International Journal of Information Management, vol. 49, p. 86-97, https://doi.org/10.1016/j.ijinfomgt.2019.03.004.
- Chopra A. AI in Supply & Procurement. 2019 Amity International Conference on Artificial Intelligence (AICAI), Artificial Intelligence (AICAI), 2019 Amity International Conference on. February 2019:308-316. doi:10.1109/AICAI.2019.8701357
- Krebs, K. D. (2020). How Can the Dod Adopt Commercial-Style Artificial Intelligence for Procurement? Artificial-Intelligence Capabilities, NPS-CM-20-152, https://dair.nps.edu/handle/123456789/4159
- McGroarty, F., Booth, A., Gerding, E., & Chinthalapati, V. L. R. (2019). High frequency trading strategies, market fragility and price spikes: an agent based model perspective. Annals of Operations Research, 282(1/2), 217–244. https://doi-org.pxz.iubh.de:8443/10.1007/s10479-018-3019-4
- Mitchell Bronwyn, & Trebes Barry. (2018). 1. Procurement. In Managing Reality (3rd Edition) - Complete Set. ICE Publishing.
- Pierre Marquis, Odile Papini, & Henri Prade. (2020). A Guided Tour of Artificial Intelligence Research: Volume II: AI Algorithms. Springer.
- Sivakriskul, K. & Phienthrakul, T. (2021): Product Category Recommendation System Using Markov Model. In: Kaiser M.S., Xie J., Rathore V.S. (eds) Information and Communication Technology for Competitive Strategies (ICTCS 2020). Lecture Notes in Networks and Systems, vol 190. Springer, Singapore. https://doi-org.pxz.iubh.de:8443/10.1007/978-981-16-0882-7_60
- Torres Berru Y., López Batista V.F., Torres-Carrión P., Jimenez M.G. (2020): Artificial Intelligence Techniques to Detect and Prevent Corruption in Procurement: A Systematic Literature Review. In: Botto-Tobar M., Zambrano Vizuete M., Torres-Carrión P., Montes León S., Pizarro Vásquez G., Durakovic B. (eds) Applied Technologies. ICAT 2019. Communications in Computer and Information Science, vol 1194. Springer, Cham. https://doi-org.pxz.iubh.de:8443/10.1007/978-3-030-42520-3_21
- Zhou, R., Pang, J., Wang, Z., Lui, J. C. S., & Li, Z. (2021): A Truthful Procurement Auction for Incentivizing Heterogeneous Clients in Federated Learning. 2021 IEEE 41st International Conference on Distributed Computing Systems (ICDCS), Distributed Computing Systems (ICDCS), 2021 IEEE 41st International Conference on, ICDCS, 183–193. https://doi-org.pxz.iubh.de:8443/10.1109/ICDCS51616.2021.00026

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Medical NLP and Medical Robotics

Module Code: DLMAIEMNMR

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEHCMI01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Ulrich Kerzel (Medical NLP) / Prof. Dr. Ulrich Kerzel (Medical Robotics and Devices)

Contributing Courses to Module

- Medical NLP (DLMAIEMNMR01)
- Medical Robotics and Devices (DLMAIEMNMR02)

Module Exam Type

Module Exam	Split Exam
	Medical NLP • Study Format "Distance Learning": Written Assessment: Written Assignment Medical Robotics and Devices • Study Format "Distance Learning": Written Assessment: Case Study

Weight of Module

see curriculum

Module Contents

Medical NLP

- Introduction to NLP
- Language Modelling
- NLP with Deep Learning
- NLP Tasks
- Application Scenarios & Case Studies

Medical Robotics and Devices

- Internet of Medical Things
- Wearable and Implantable Devices
- Fundamentals of Robotics
- Navigation and Registration
- Treatment Planning
- Design of Medical Robots

Learning Outcomes

Medical NLP

On successful completion, students will be able to

- understand the concepts of natural language processing.
- analyze texts with statistical models.
- create deep learning-based NLP models.
- evaluate which NLP method is appropriate for a specific application scenario.

Medical Robotics and Devices

On successful completion, students will be able to

- understand the current developments, the main issues, and the challenges of robotics for the medical field.
- describe typical applications and requirements of medical robots.
- address the problems of navigation and registration in medical field.
- solve basic design issues related to medical robots.
- understand and describe the main wearable and implantable medical devices.
- understand the main characteristics and challenges related to the internet of medical things.

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 and Engineering.	All Master Programs in the IT & Technology field.

Medical NLP

Course Code: DLMAIEMNMR01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEHCMI01

Course Description

The course gives an introduction into natural language processing (NLP) with special focus to application in healthcare. After a general introduction, the course covers conventional statistical NLP models before turning to modern deep learning-based approaches based on word embeddings, recurrent neural networks or transformers. Subsequently, a range of application areas is discussed that can be used in healthcare. The course closes with a detailed analysis of application scenarios and case studies of natural language processing in healthcare.

Course Outcomes

On successful completion, students will be able to

- understand the concepts of natural language processing.
- analyze texts with statistical models.
- create deep learning-based NLP models.
- evaluate which NLP method is appropriate for a specific application scenario.

Contents

1. Introduction to NLP
   - 1.1 Human Language and Meaning of Words
   - 1.2 Challenges in NLP
   - 1.3 Bias
   - 1.4 Evaluation Metrics
2. Language Modeling and Word Representation
   - 2.1 N-Grams
   - 2.2 Bag of Words and Word Vectors
   - 2.3 Word Embedding Models
3. NLP with Deep Learning
   - 3.1 Recurrent Neural Network based Approaches
   - 3.2 Transformer based Approaches

4. NLP Tasks
   - 4.1 Named Entity Recognition
   - 4.2 Sentiment Analysis
   - 4.3 Text Summarization
   - 4.4 Machine Translation
   - 4.5 Speech Recognition & Synthesis
   - 4.6 Text Understanding & Information Extraction

5. Application Scenarios & Case Studies
   - 5.1 Medical Text Analysis
   - 5.2 Medical Chatbots
   - 5.3 Diagnostics and Therapy
   - 5.4 Drug Discovery

Literature

Compulsory Reading

Further Reading

- Clark, A., Fox, C., & Lappin, S. (Eds.). (2010). Handbook of computational linguistics and natural language processing. Malden, MA: Wiley-Blackwell.
- Devlin, J. et al (2018). Bert: Pre-training of deep bidirectional transformers for language understanding. arXiv preprint arXiv:1810.04805.
- Ethayarajh, K. (2020). Is Your Classifier Actually Biased? Measuring Fairness under Uncertainty with Bernstein Bounds. Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics
- Fraser, K.C., Meltzer, J., & Rudzicz, F. (2016). Linguistic Features Identify Alzheimer's Disease in Narrative Speech. Journal of Alzheimer's disease : JAD, 49 2, 407-22 .
- Garrido-Muñoz I, et al. (2021) A Survey on Bias in Deep NLP. Applied Sciences. 11(7):3184. https://doi.org/10.3390/app11073184
- Juhn, Y., Liu, H. (2020): Artificial intelligence approaches using natural language processing to advance EHR-based clinical research, Journal of Allergy and Clinical Immunology, Volume 145, Issue 2, Pages 463-469
- Kandpal, P. et al (2020): Contextual Chatbot for Healthcare Purposes (using Deep Learning), Fourth World Conference on Smart Trends in Systems, Security and Sustainability (WorldS4), 2020, pp. 625-634, doi: 10.1109/WorldS450073.2020.9210351
- Martin, J., Jurafsky, D. (2020): Speech and Language Processing, 3rd ed., Prentice Hall.
- Masrani, V. et al (2017): Domain Adaptation for Detecting Mild Cognitive Impairment. Canadian Conference on AI.
- Murray, G. (2018). Language-Based Automatic Assessment of Cognitive and Communicative Functions Related to Parkinson's Disease.
- Schick, T., Udupa, S., & Schütze, H. (2021). Self-diagnosis and self-debiasing: A proposal for reducing corpus-based bias in nlp. arXiv preprint arXiv:2103.00453.
- Sorin, V. et al. (2020): Deep Learning for Natural Language Processing in Radiology—Fundamentals and a Systematic Review, Journal of the American College of Radiology, Volume 17, Issue 5, Pages 639-648
- Sun, T. et al. (2019). Mitigating Gender Bias in Natural Language Processing: Literature Review, arXiv pre-print 1906.08976
- Tay, Y., et al. (2020). Efficient transformers: A survey. arXiv preprint arXiv:2009.06732.
- Vaswani, et al (2017). Attention is all you need. In Advances in neural information processing systems (pp. 5998-6008).
- Zand, A. et al (2020): An Exploration Into the Use of a Chatbot for Patients With Inflammatory Bowel Diseases: Retrospective Cohort Study. Journal of medical Internet research, 22(5), e15589. https://doi.org/10.2196/15589

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Medical Robotics and Devices

Course Code: DLMAIEMNMR02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEHCMI01

Course Description

The growing interconnection between medical devices and medical objects is leading to the so-called Internet of Medical Things, which can be seen as a specific use case of the more generic Internet of Things. However, medical objects do have some peculiarities, for instance due to specific, sometimes more stringent regulations and requirements. This course introduces two main kind of medical objects, namely medical robots and wearable and implantable devices. The first part focuses on wearable and implantable devices, for use in patient monitoring or activity tracking. The second part focuses medical robots, by presenting the fundamentals as well as specific topics in the medical field, such as navigation, registration and treatment planning. The course ends with an overview on the main issues to be considered when designing a medical robot.

Course Outcomes

On successful completion, students will be able to

- understand the current developments, the main issues, and the challenges of robotics for the medical field.
- describe typical applications and requirements of medical robots.
- address the problems of navigation and registration in medical field.
- solve basic design issues related to medical robots.
- understand and describe the main wearable and implantable medical devices.
- understand the main characteristics and challenges related to the internet of medical things.

Contents

1. Internet of Medical Things
   - 1.1 Medical Robots
   - 1.2 Data-Driven Medicine
   - 1.3 Image Management
   - 1.4 Cybersecurity
   - 1.5 Current Legislation and Trends

2. Weareable and Implantable Medical Devices
   - 21 Weareable Devices
   - 22 Weareable Sensors for Monitoring
   - 23 Implantable Devices

3. Fundamentals of Robotics: Kinematics
   - 31 Kinematics
   - 32 Position and Orientation of a Rigid Body
   - 33 Joint Kinematics
   - 34 Forward Kinematics
   - 35 Inverse Kinematics
   - 36 Differential Kinematics

4. Navigation and Registration
   - 41 Digitally Reconstructed Radiographs
   - 42 Points and Landmarks
   - 43 Contour-Based Registration
   - 44 Intensity-Based Registration
   - 45 Image Deformation
   - 46 Hand-Eye Calibration

5. Treatment Planning
   - 51 Orthopedic Surgery
   - 52 Radiosurgery
   - 53 Four-Dimensional Planning

6. Design of Medical Robots
   - 61 Kinematics and Dynamics
   - 62 Design Methods
   - 63 Actuators, Sensors, and Material
   - 64 Security and Safety

Literature
Compulsory Reading
Further Reading ' Cardona, M., Solanki, V. K., & Garcia Cena, C. E. (Eds.). (2021). Internet of Medical Things. Boca Raton: CRC Press. ' Schweikard, A., & Ernst, F. (2015). Medical Robotics. Springer International Publishing. https://doi.org/10.1007/978-3-319-22891-4 ' Troccaz, J. (Ed.). (2013). Medical Robotics. John Wiley and Sons. https://doi.org/10.1002/9781118562147

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Case Study

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

AI for Analytics, Personalization and Recommender Systems

Module Code: DLMAIEAPRS

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEECMDF01	MA	10	300 h

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

Module Coordinator

N.N. Professur für Artificial Intelligence (AI in Marketing and Analytics) / N.N. Professur für Artificial Intelligence (Personalization and Recommender Systems)

Contributing Courses to Module

- AI in Marketing and Analytics (DLMAIEAPRS01)
- Personalization and Recommender Systems (DLMAIEAPRS02)

Module Exam Type

Module Exam	Split Exam
	AI in Marketing and Analytics • Study Format "Distance Learning": Oral Assignment Personalization and Recommender Systems • Study Format "Distance Learning": Oral Assignment

Weight of Module

see curriculum

Module Contents

AI in Marketing and Analytics

- Foundation and Introduction
- Descriptive Methods
- Predictive Methods
- Prescriptive Methods
- Perspectives

Personalization and Recommender Systems

- Foundation and Introduction
- Collaborative Filtering
- Content-Based Filtering
- Hybrid Recommender Systems
- Large-Scale Recommender Systems
- Perspectives

Learning Outcomes

AI in Marketing and Analytics

On successful completion, students will be able to

- understand the concepts of data driven marketing.
- apply descriptive, predictive, and prescriptive marketing and analytics methods.
- evaluate applications of artificial intelligence in marketing and analytics.

Personalization and Recommender Systems

On successful completion, students will be able to

- understand the concepts of personalization and recommender systems.
- evaluate the appropriate approach of recommender system methods for specific application scenarios.
- apply artificial intelligence methods in the field of recommender systems and personalization.
- evaluate the development of new technologies and its application in personalization and recommender systems.

Links to other Modules within the Study Program

This module is similar to other modules in the fields of Data Science & Artificial Intelligence and Marketing & Sales.

Links to other Study Programs of the University

All Master Programs in the IT & Technology and Marketing & Communication fields.

AI in Marketing and Analytics

Course Code: DLMAIEAPRS01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEECMDF01

Course Description

This course lays the foundation to apply methods from artificial intelligence in the field of marketing and analytics. The course starts with a general introduction of the basic concepts and then covers the three main areas in detail: descriptive, predictive and prescriptive methods. In each area, the relevant concepts are introduced and discussed. In particular the potential of using artificial intelligence methods in each of these areas is highlighted. The course closes with a discussion of further perspective, illustrating how this field is likely to develop in the next few years.

Course Outcomes

On successful completion, students will be able to

- understand the concepts of data driven marketing.
- apply descriptive, predictive, and prescriptive marketing and analytics methods.
- evaluate applications of artificial intelligence in marketing and analytics.

Contents

1. Foundations and Introduction
   - 1.1 Basic Building Blocks
   - 1.2 Channels & Strategies
2. Descriptive Methods
   - 2.1 Business Intelligence
   - 2.2 Brand Metrics and Value
   - 2.3 Customer Segmentation, Journey and Acquisition Cost
   - 2.4 Market Basket & Assortment Analysis
   - 2.5 Search Analytics

3. Predictive Methods
   - 3.1 Customer Churn and Retention
   - 3.2 Customer Lifetime Value (CLV) Estimation
   - 3.3 Sales Forecasting and Budgeting
   - 3.4 Search-Optimization

4. Prescriptive Methods
   - 4.1 Pricing Strategies
   - 4.2 Upselling, Cross-selling
   - 4.3 Marketing Campaign Analytics and Optimization
   - 4.4 Targeting
   - 4.5 Marketing Experiments, Tests & Evaluation

5. Perspectives
   - 5.1 Closed Loop vs. Human-in-the-Loop, Active Learning
   - 5.2 Cross-Channel, Omnichannel and Subscriptions

Literature

Compulsory Reading

Further Reading

- Barker, M., Barker, D., Bormann, N. (2016): Social Media Marketing: A Strategic Approach 2nd Edition, Cengage Learning
- Butow, E. et al. (2020): Ultimate Guide to Social Media Marketing. Entrepreneur Press, Irvine
- Chandler, St. (2012): Own your niche, Authority Publishing
- Chaters, B. (2011): Mastering Search Analytics, O'Reilley Publishing
- Dib, A. (2018): The 1-Page Marketing Plan, Page Two
- Enge, E., Spencer, St., Stricchiola, J. (2015): The Art of SEO, 3rd ed. O'Reilly Media
- Grigsby, M.(2018): Marketing Analytics: A Practical Guide to Improving Consumer Insights Using Data Techniques, 2nd Edition, London
- Kerin, R. , Hartley, St. (2019): Marketing: The Core, 8th ed., McGraw-Hill
- McKinnon, B. (2019): What's Your Point?: The Brand Arrow - Define Your Point. Grow Your Brand, Grace and Down Publishing

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Personalization and Recommender Systems

Course Code: DLMAIEAPRS02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, DLMAIIAC01, DLMAIEECMDF01

Course Description

This course focuses on methods and applications of personalization techniques and recommender systems. After a general introduction to the topic and its foundation, content-based and collaborative filtering methods are discussed. Recommender systems play a vital role in modern personalization methods and both hybrid as well as large-scale approaches for recommender systems are discussed in detail in dedicated learning units. Finally, the course gives an outlook on developments of next generation methods as well as integration of further analytical methods such as causal analysis, multi-stakeholder and multi-objective recommender systems.

Course Outcomes

On successful completion, students will be able to

- understand the concepts of personalization and recommender systems.
- evaluate the appropriate approach of recommender system methods for specific application scenarios.
- apply artificial intelligence methods in the field of recommender systems and personalization.
- evaluate the development of new technologies and its application in personalization and recommender systems.

Contents

1. Foundation and Introduction
   - 1.1 History and Application Domains of Recommender Systems
   - 1.2 Basic Building Blocks:
   - 1.3 Levels of Personalization & Recommender Archetypes
   - 1.4 Business Goals & Evaluation Strategies
2. Collaborative Filtering
   - 2.1 Neighborhood-Based Approaches:
   - 2.2 Graph-Based Approaches
   - 2.3 Latent Factor Models
   - 2.4 Bayesian Personalized Ranking (BPR)

3. Content-based Filtering
   - 3.1 Content Types & Strategies across Domains
   - 3.2 Factorization Machines & Classification

4. Hybrid Recommender Systems
   - 4.1 User- vs. Item-based Recommendations
   - 4.2 Monolithic, Mixed Hybrid and Ensemble Recommenders

5. Large-Scale Recommender Systems
   - 5.1 Information Retrieval Dichotomy
   - 5.2 Approximate Nearest Neighbour Search
   - 5.3 Serving Recommendations in Production

6. Perspectives
   - 6.1 (Contextual) Multi-Armed Bandits
   - 6.2 Deep Learning and Reinforcement Learning Based Approaches
   - 6.3 Causality-Aware Approaches
   - 6.4 Multi-Stakeholder and Multi-Objective Recommender Systems

Literature

Compulsory Reading

Further Reading

- Aggarwal, C. (2016): Recommender Systems, Springer.
- Falk, K, (2019): Practical Recommender Systems, Manning Publications.
- Jannach, D., Zanker, M., Felfernig, A, Friedrich, G. (2010): Recommender Systems: An Introduction, Cambridge University Press.
- Moreira, G., Cunha, A. (2020): Deep Learning for News Recommender Systems, LAP LAMBERT Academic Publishing.
- Pearl, J., Glymour, M., & Jewell, N. P. (2016). Causal inference in statistics: A primer. Wiley.
- RecSys '20: Fourteenth ACM Conference on Recommender Systems, Association for Computing Machinery, New York, NY, United States, ISBN 78-1-4503-7583-2
- Sutton,R. S.,& Barto, A. G. (1998). Reinforcement learning: An introduction. MIT Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Oral Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Industrial Automation and Computer Vision for Autonomous Systems

Module Code: DLMAIEIACVAS

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	10	300 h

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

Module Coordinator

Prof. Dr. Leonardo Riccardi (Industrial Automation) / Prof. Dr. Thomas Zöller (Computer Vision for Autonomous Systems)

Contributing Courses to Module

- Industrial Automation (DLMDSINDA01)
- Computer Vision for Autonomous Systems (DLMAIEFSCVAS02)

Module Exam Type

Module Exam	Split Exam
	Industrial Automation • Study Format "Distance Learning": Exam, 90 Minutes Computer Vision for Autonomous Systems • Study Format "Distance Learning": Written Assessment: Written Assignment

Weight of Module

see curriculum

Module Contents

Industrial Automation

- Mathematical frameworks for the formal description of discrete event systems
- Analysis and evaluation methods
- Simulation of discrete event systems
- Supervisory control
- Advanced issues (fault diagnosis, adaptive supervision, optimization)

Computer Vision for Autonomous Systems

- Image Formation and Acquisition
- Sensors for Image Acquisition
- Feature Extraction
- Object Detection and Tracking
- Segmentation

Learning Outcomes

Industrial Automation

On successful completion, students will be able to

- identify the main issues related to industrial automation and Industry 4.0 automation in particular.
- describe a discrete event system in a formal way by means of different mathematical models.
- analyze the performance of a system using formalisms and numerical simulation approaches.
- choose the best formalism for a given design scenario and formulate requirements.
- design and implement a supervisory controller to fulfill requirements.
- understand advanced topics related to Industry 4.0 industrial automation.

Computer Vision for Autonomous Systems

On successful completion, students will be able to

- understand color and light.
- understand image formation.
- name commonly used sensors for image acquisition.
- perform basic image processing operations.
- detect features in an image.
- track objects in images and videos.
- apply commonly used algorithms for segmentation.

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 Engineering.	All Master Programmes in the IT & Technology field.

Industrial Automation

Course Code: DLMDSINDA01

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

Course Description

Production systems can be described as discrete event systems where the evolution is characterized by the occurrence of events. In the era of Industry 4.0 and highly-flexible manufacturing, there is the need to provide adequate means for the modeling, analysis, design, and control of flexible production environments.This course introduces several modeling approaches for the mathematical description of discrete event systems, such as Automata, Petri Nets, and Markov processes. Each approach is presented in both theory and practice with examples taken from the industry. The approaches are grouped into logic—where only the logic sequence of events determines the evolution—and timed, where the time schedule of the events also plays an important role. Although simple discrete event systems can be analyzed mathematically, complex systems need the support of computer simulation. The main issues concerning the simulation of discrete event systems are addressed.The final part of this course introduces the concept of supervisory control, which aims at changing the properties of a given system to improve specified behaviors and fulfill defined design specifications. Supervisory control is addressed both from the theoretical practical sides, describing how it can be implemented in a modern industrial environment.The course wraps up with discussion of interesting applications for modeling and design approaches, e.g., in the modeling and analysis of an industrial production unit. Additional conversation on topics like fault-diagnosis, decentralized and distributed supervision, optimization, and adaptive supervision provide a contingent connection between classical industrial automation and the recent, (big) data-driven, flexible, Industry 4.0 advanced industrial automation.

Course Outcomes

On successful completion, students will be able to

- identify the main issues related to industrial automation and Industry 4.0 automation in particular.
- describe a discrete event system in a formal way by means of different mathematical models.
- analyze the performance of a system using formalisms and numerical simulation approaches.
- choose the best formalism for a given design scenario and formulate requirements.
- design and implement a supervisory controller to fulfill requirements.
- understand advanced topics related to Industry 4.0 industrial automation.

Contents

1. Introduction to Production Systems
   - 1.1 Basic concepts and definitions
   - 1.2 Industrial supervision and control
   - 1.3 Challenges
   - 1.4 Trends

2. Automata
   - 2.1 Preliminaries
   - 2.2 Deterministic finite automata
   - 2.3 Non-deterministic finite automata
   - 2.4 Properties

3. Petri nets
   - 3.1 Preliminaries
   - 3.2 Modeling systems
   - 3.3 Properties
   - 3.4 Analysis methods

4. Timed models
   - 4.1 Timed automata
   - 4.2 Markov processes
   - 4.3 Queuing theory
   - 4.4 Timed Petri Nets

5. Simulation of discrete event systems
   - 5.1 Basic concepts
   - 5.2 Working principles
   - 5.3 Performance analysis
   - 5.4 Software tools

6. Supervisory control
   - 6.1 Basic concepts
   - 6.2 Specifications
   - 6.3 Synthesis
   - 6.4 Performance analysis
   - 6.5 Implementation

7. Applications
   - 7.1 Production system supervision
   - 7.2 Monitoring and diagnosis of faults
   - 7.3 Distributed and de-centralized supervision
   - 7.4 Model-based optimization of production systems
   - 7.5 Adaptive supervisory control

Literature

Compulsory Reading

Further Reading

- Cassandras, C. G., & Lafortune, S. (2009). Introduction to discrete event systems. Springer.
- Hooley, G., Nicoulaud, B., Rudd, J. M., & Piercy, N. (2019). Marketing strategy and competitive positioning. Pearson.
- Kaplan, R., Norton, D., & Rugelsjoen, B. (2010). Managing alliances with the balanced scorecard. Harvard Business Review, 88(1/2), 114–120.
- Linz, P. (2006). An introduction to formal languages and automata. Jones & Bartlett Learning.
- Reisig, W. (2013). Understanding Petri nets: Modeling techniques, analysis methods, case studies. Springer.
- Stewart, J. B. (2013, October 14). The collapse: How a top legal firm destroyed itself. The New Yorker.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	30 h	30 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☑ Exam Template	☑ Slides

Computer Vision for Autonomous Systems

Course Code: DLMAIEFSCVAS02

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

Course Description

One of the main capabilities of an autonomous system, for instance a robot, is the ability to view and recognize objects. Object detection, recognition and tracking are advanced task of a modern computer vision system. This course introduces the fundamentals of computer vision, which rely on the beautiful mathematics of image formation as well as the technology of image acquisition. The images are further processed to extract information. Feature detection, object detection, object tracking and image segmentation are described. A chapter on sensors gives an overview of sensors used for computer vision in contemporary robotics and industry.

Course Outcomes

On successful completion, students will be able to

- understand color and light.
- understand image formation.
- name commonly used sensors for image acquisition.
- perform basic image processing operations.
- detect features in an image.
- track objects in images and videos.
- apply commonly used algorithms for segmentation.

Contents

1. Image Formation & Acquisition
   - 1.1 Light
   - 1.2 Color
   - 1.3 Perspective Camera
   - 1.4 Camera Calibration
   - 1.5 Single and Multiple View Geometry

2. Sensors for Computer Vision
   - 2.1 Camera & Night Vision
   - 2.2 Lidar
   - 2.3 Radar
   - 2.4 Ultrasound
   - 2.5 Trends

3. Image Processing
   - 3.1 Operators
   - 3.2 Filtering and Transforms
   - 3.3 Geometric Transformations

4. Feature Detection
   - 4.1 Points
   - 4.2 Edges
   - 4.3 Lines
   - 4.4 Common Methods

5. Object Detection & Tracking
   - 5.1 Object Representation
   - 5.2 Techniques for Object Detection
   - 5.3 Network Architectures

6. Segmentation
   - 6.1 Stuff and Things
   - 6.2 Semantic Segmentation
   - 6.3 Instance Segmentation
   - 6.4 Segmentation in Videos and Feeds
   - 6.5 MOTS: Multi-Object Tracking & Segmentation

Literature

Compulsory Reading

Further Reading

- Ansari, S. (2020). Building Computer Vision Applications Using Artificial Neural Networks. Apress. https://doi.org/10.1007/978-1-4842-5887-3
- Ayyadevara, V., & Reddy, Y. (2020). Modern Computer Vision with PyTorch. Packt.
- Distante, A., & Distante, C. (2020). Handbook of image processing and computer vision: Volume 1: From energy to image. Springer International Publishing. https://doi.org/10.1007/978-3-030-38148-6
- Gonzalez, R. C., & Woods, R. E. (2017). Digital Image Processing (4th ed.). Pearson.
- Peters, J. F. (2017). Foundations of Computer Vision (Vol. 124). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-52483-2
- Szelinski, R. (2020). Computer Vision: Algorithms and Applications. (2nd ed.). Springer Nature.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

NLP and Innovative Technologies in Education

Module Code: DLMAIWNLPITE

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	DLMDSML01, DLMDSDL01, DLMAIWNLPVA01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Tim Schlippe (NLP in Education) / Prof. Dr. Tim Schlippe (NLP for Accessibility)

Contributing Courses to Module

- NLP in Education (DLMAIWNLPITE01)
- NLP for Accessibility (DLMAIWNLPITE02)

Module Exam Type	
Module Exam	**Split Exam** NLP in Education • Study Format "Distance Learning": Written Assessment: Research Essay NLP for Accessibility • Study Format "Distance Learning": Written Assessment: Research Essay
Weight of Module see curriculum	

Module Contents

NLP in Education

This course strives to elucidate current research trends in „AI in Education“ with a focus on NLP.

NLP for Accessibility

This course strives to elucidate current research trends in „NLP“ with a focus on accessibility, integration and inclusion.

Learning Outcomes

NLP in Education

On successful completion, students will be able to

- discuss current trends and topics in the research field „AI in Education“ with a focus on NLP.
- learn to understand scientific publications in this field.
- understand algorithms and methods from the field of NLP to address an enhanced education.
- understand use-case scenarios in which NLP techniques are applied.
- learn to analyze, summarize, compare and describe the methods in a research essay.

NLP for Accessibility

On successful completion, students will be able to

- discuss current trends and topics in the research field „NLP“ with a focus on accessibility, inclusion and integration.
- learn to understand scientific publications in this field.
- understand algorithms and methods from the field of NLP to address accessibility, inclusion and integration.
- understand use-case scenarios in which NLP techniques are applied.
- learn to analyze, summarize, compare and describe the methods in a research essay.

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.

NLP in Education

Course Code: DLMAIWNLPITE01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIWNLPVA01

Course Description

Access to education is one of people's most important assets and ensuring inclusive and equitable quality education is goal 4 of United Nation's Sustainable Development Goals. Distance learning in particular can create education in areas where there are no educational institutions or in times of a pandemic. There are more and more offers for distance learning worldwide and challenges like the physical absence of the teacher and the classmates or the lack of motivation of the students are countered with technical solutions like videoconferencing systems and gamification of learning. The research area "AI in Education" addresses the application and evaluation of Artificial Intelligence (AI) methods in the context of education and training. One of the main focuses of this research is to analyze and improve teaching and learning processes. This course strives to elucidate current research trends in „AI in Education" with a focus on NLP. The students learn to independently analyze selected topics and case studies and link them with well-known concepts, as well as critically question and discuss them.

Course Outcomes

On successful completion, students will be able to

- discuss current trends and topics in the research field „AI in Education" with a focus on NLP.
- learn to understand scientific publications in this field.
- understand algorithms and methods from the field of NLP to address an enhanced education.
- understand use-case scenarios in which NLP techniques are applied.
- learn to analyze, summarize, compare and describe the methods in a research essay.

Contents

- The seminar covers current topics in the research field „AI in Education" with a focus on NLP. Each participant must write a research essay on a topic assigned to him/her.

Literature
Compulsory Reading
Further Reading ' Chen, L., Chen, P., & Lin, Z. (2020): Artificial Intelligence in Education: A Review. IEEE Access 8 (2020), 75264–75278. ' Heffernan, N. (2014): The ASSISTments Ecosystem: Building a Platform that Brings Scientists and Teachers Together for Minimally Invasive Research on Human Learning and Teaching. International Journal of Artificial Intelligence in Education 24 (12 2014). ' Jurafsky, D., & Martin, J. H. (2020): Speech and language processing (3rd ed.). PrenticeHall. https://web.stanford.edu/~jurafsky/slp3 ' Libbrecht, P., Declerck, T., Schlippe, T., Mandl, T., & Schiffner, D. (2020): NLP for Student and Teacher: Concept for an AI based Information Literacy Tutoring System. In The 29th ACM International Conference on Information and Knowledge Management (CIKM2020). Galway, Ireland. ' Schlippe, T. & Sawatzki, J.(2021): AI-based Multilingual Interactive Exam Preparation. In The Learning Ideas Conference 2021 (14th annual conference). ALICE - Special Conference Track on Adaptive Learning via Interactive, Collaborative and Emotional Approaches. New York, USA. ' Schlippe, T. & Sawatzki, J. (2021): Cross-Lingual Automatic Short Answer Grading. In Proceedings of The 2nd International Conference on Artificial Intelligence in Education Technology (AIET 2021). Wuhan, China.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

NLP for Accessibility

Course Code: DLMAIWNLPITE02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIWNLPVA01

Course Description

In recent years there has been an increasing interest in accessibility, inclusion and integration issues. This interest is mainly due to the greater importance of the Web and the need to provide equal opportunity to everyone including people with diverse diabilities or older people and to overcome language and cultural barriers. The role of assistive technologies based on NLP has gained importance. This course strives to elucidate current research trends in „NLP“ with a focus on accessibility, integration and inclusion. The students learn to independently analyze selected topics and case studies and link them with well-known concepts, as well as critically question and discuss them.

Course Outcomes

On successful completion, students will be able to

- discuss current trends and topics in the research field „NLP“ with a focus on accessibility, inclusion and integration.
- learn to understand scientific publications in this field.
- understand algorithms and methods from the field of NLP to address accessibility, inclusion and integration.
- understand use-case scenarios in which NLP techniques are applied.
- learn to analyze, summarize, compare and describe the methods in a research essay.

Contents

- The course covers current topics in the research field „NLP“ with a focus on accessibility, inclusion and integration.

Literature
Compulsory Reading
Further Reading ' Al-Thanyyan, S. S. & Azmi, A. (2021): Automated Text Simplification: A Survey. ACM Computing Surveys, Vol. 54, Issue 2, pp. 1–36. ' Jurafsky, D., & Martin, J. H. (2020): Speech and language processing (3rd ed.). PrenticeHall. https://web.stanford.edu/~jurafsky/slp3 ' Klaper, D., Ebling, S., & Volk, M. (2013): Building a German/Simple German Parallel Corpus for Automatic Text Simplification. The Second Workshop on Predicting and Improving Text Readibility for Target Reader Populations. ' Schlippe, T., Alessai, S., El-Taweel, G., Wölfel, M., & Zaghouani, W. (2020): Visualizing Voice Characteristics with Type Design in Closed Captions for Arabic. Cyberworlds. Caen, France.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

Cognitive Computer Vision

Module Code: DLMAIWCCV

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	' DLMDSML01, DLMDSDL01, DLMAIRIL01 ' DLMDSML01, DLMDSDL01, DLMAIRIL01, IDLMAIWFCV01, DLMAIWFCV02, DLMAIWCCV01	MA	10	300 h

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

Module Coordinator
N.N (High-Level Vision) / N.N (Project: Computer Vision)

Contributing Courses to Module
' High-Level Vision (DLMAIWCCV01) ' Project: Computer Vision (DLMAIWCCV02)

Module Exam Type	
Module Exam	**Split Exam** <u>High-Level Vision</u> • Study Format "Distance Learning": Written Assessment: Written Assignment <u>Project: Computer Vision</u> • Study Format "Distance Learning": Written Assessment: Project Report

Weight of Module

see curriculum

Module Contents

High-Level Vision

- Classification
- Recognition
- Image Synthesis
- Computer Vision and NLP
- Current Challenges

Project: Computer Vision

In this course, the students will work on a practical Computer Vision use-case based on a number of choices in the task description.

Learning Outcomes

High-Level Vision

On successful completion, students will be able to

- understand current approaches to image classification and retrieval.
- summarize goals and methods of scene understanding.
- disambiguate different tasks in object recognition, semantic and instance segmentation.
- explain solutions to common problems in image enhancement.
- understand the connection of Computer Vision to other forms of cognitive computing like NLP.
- appreciate current challenges in Computer Vision with respect to model training, fairness, and robustness.

Project: Computer Vision

On successful completion, students will be able to

- formulate and implement a Computer Vision use case.
- transfer knowledge of Computer Vision methodology to a real-world use-case.
- synthesize a solution to a complex Computer Vision task from known building blocks.
- analyze the suitability of alternative approaches with respect to the project task.
- critically reason about pertinent design choices.
- make apposite architectural conceptions.

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.

High-Level Vision

Course Code: DLMAIWCCV01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01

Course Description

In this course, a thorough introduction to the higher-level cognitive aspects of Computer Vision like classification, recognition, and semantic segmentation is given and touch-points to the field of Natural Language Processing are illuminated. Moreover, the highly relevant field of image enhancement is detailed. Finally, students are sensitized to challenges in Computer Vision and current development directions to address these issues.

Course Outcomes

On successful completion, students will be able to

- understand current approaches to image classification and retrieval.
- summarize goals and methods of scene understanding.
- disambiguate different tasks in object recognition, semantic and instance segmentation.
- explain solutions to common problems in image enhancement.
- understand the connection of Computer Vision to other forms of cognitive computing like NLP.
- appreciate current challenges in Computer Vision with respect to model training, fairness, and robustness.

Contents

1. Classification
   - 1.1 Classifying Image Content
   - 1.2 Image Retrieval and Tagging
   - 1.3 Scene Understanding
2. Recognition
   - 2.1 Object Recognition
   - 2.2 Semantic and Instance Segmentation
   - 2.3 Face Recognition

3. Image Synthesis
   - 3.1 Synthesizing Images and Image Enhancement (Superresolution)
   - 3.2 Extrapolation
   - 3.3 Artistic Style Transfer / Domain Transfer

4. Computer Vision and NLP
   - 4.1 Scene Description
   - 4.2 Visual Question Answering
   - 4.3 Synthesizing Images from Descriptions

5. Current Challenges
   - 5.1 Fairness and Explainability in Computer Vision
   - 5.2 Self Supervised and Contrastive Learning
   - 5.3 Robust Computer Vision

Literature

Compulsory Reading

Further Reading

- Forsyth, D., Ponce, J. (2012): Computer Vision - A Modern Approach, Prentice Hall.
- Goodfellow, I., Bengio, Y., Courville, A. (2016): Deep Learning. MIT Press. Cambridge, MA.
- Klette, R. (2014): Concise Computer Vision: An Introduction into Theory and Algorithms, Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Online Lecture

Information about the examination	
Examination Admission Requirements	**BOLK:** yes **Course Evaluation:** no
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
110 h	0 h	20 h	20 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☑ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☑ Shortcast	☐ Live Tutorium/Course Feed
☑ Audio	☐ Reader
☐ Exam Template	☑ Slides

Project: Computer Vision

Course Code: DLMAIWCCV02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSML01, DLMDSDL01, DLMAIRIL01, IDLMAIWFCV01, DLMAIWFCV02, DLMAIWCCV01

Course Description

In this course, the students will work on a practical Computer Vision use-case based on a number of choices in the task description. The choice of approach, the system or software implemented, and the resulting performance on the task are to be reasoned about, explained, and documented. To this end, students make practical use of the methodological knowledge acquired in previous courses by applying them to relevant real-world problems.

Course Outcomes

On successful completion, students will be able to

- formulate and implement a Computer Vision use case.
- transfer knowledge of Computer Vision methodology to a real-world use-case.
- synthesize a solution to a complex Computer Vision task from known building blocks.
- analyze the suitability of alternative approaches with respect to the project task.
- critically reason about pertinent design choices.
- make apposite architectural conceptions.

Contents

- This course aims at the practical implementation of a Computer Vision project. Students can choose from a list of project topics as detailed in the task description.

Literature

Compulsory Reading

Further Reading

- Dadhich, A. (2018): Practical Computer Vision. Pakt Publishing. Burmingham, UK.
- Hornberg, A. (2017): Handbook of Machine and Computer Vision. 2nd edition. Wiley-VCH. Weinheim, Germany.
- Shanmugamani, R. (2018): Deep Learning for Computer Vision. Pakt Publishing. Burmingham, UK.
- Solem, J. E. (2012): Programming Computer Vision with Python. O'Reilly. Cambridge, MA.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Project Report

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
120 h	0 h	30 h	0 h	0 h	150 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☐ Reader
☐ Exam Template	☑ Slides

4. Semester

Master Thesis

Module Code: MMTHE

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	none	MA	30	900 h

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

Module Coordinator

Degree Program Advisor (SGL) (Master Thesis) / Degree Program Advisor (SGL) (Colloquium)

Contributing Courses to Module

- Master Thesis (MMTHE01)
- Colloquium (MMTHE02)

Module Exam Type

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

Weight of Module

see curriculum

Module Contents

Master Thesis

- Master's thesis

Colloquium

- Colloquium on the Master's thesis

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
This module is similar to other modules in the field(s) of Methods.	All Master Programmes in the Business & Management field(s).

Master Thesis

Course Code: MMTHE01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		27	none

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	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Master Thesis

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
810 h	0 h	0 h	0 h	0 h	810 h

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Study Format myStudies

Study Format	Course Type
myStudies	Thesis

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Written Assessment: Master Thesis

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
810 h	0 h	0 h	0 h	0 h	810 h

Instructional Methods	
☐ Learning Sprints®	☑ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☑ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Colloquium

Course Code: MMTHE02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		3	none

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 Distance Learning

Study Format	Course Type
Distance Learning	Thesis Defense

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Presentation: Colloquium

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	0 h	0 h	0 h	90 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	

Study Format myStudies

Study Format	Course Type
myStudies	Thesis Defense

Information about the examination	
Examination Admission Requirements	**BOLK:** no **Course Evaluation:** no
Type of Exam	Presentation: Colloquium

Student Workload					
Self Study	**Presence**	**Tutorial**	**Self Test**	**Practical Experience**	**Hours Total**
90 h	0 h	0 h	0 h	0 h	90 h

Instructional Methods	
☐ Learning Sprints®	☐ Review Book
☐ Course Book	☐ Creative Lab
☐ Vodcast	☐ Guideline
☐ Shortcast	☐ Live Tutorium/Course Feed
☐ Audio	☑ Slides
☐ Exam Template	