MODULE HANDBOOK

Master of Science

Master Computer Science (CSE-MACS-120)

120 CP

Campus Studies

As of April 1st, 2026

INTERNATIONAL
UNIVERSITY OF
APPLIED SCIENCES

Classification: Consecutive

Contents

Programming with Python

Module Code: CSEMDSPWP

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 (CSEMDSPWP01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies 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: CSEMDSPWP01

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 rationale and application within important libraries related to data science and artificial intelligence and 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. Important libraries
   - 3.1 Standard Python library
   - 3.2 Scientific calculations
   - 3.3 Machine learning libraries
   - 3.4 Visualization
   - 3.5 Accessing databases

4. Errors and exceptions
   - 4.1 Syntax errors
   - 4.2 Handling and raising exceptions
   - 4.3 User-defined exceptions

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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Software Engineering: Software Processes

Module Code: CSEMCSSESP-01

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. Sebastian Lempert (Software Engineering: Software Processes)

Contributing Courses to Module

- Software Engineering: Software Processes (CSEMCSSESP01-01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Written Assessment: Case Study	

Weight of Module

see curriculum

Module Contents

- Software process modeling
- Basic software life cycles
- Agile and lean processes
- The Software Product Life Cycle
- Governance and management of software processes

Learning Outcomes

Software Engineering: Software Processes

On successful completion, students will be able to

- describe the role of software processes and lifecycle models in software engineering from initialization to the withdrawal of a software system.
- describe the notations used for software processes and discuss their relative advantages.
- discuss the differences and commonalities of plan-driven and agile approaches.
- select an appropriate process model for specific application cases and discuss their advantages and disadvantages.
- adapt (tailor-) selected process models to an individual situation.

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 Computer Science & Software Development.	All Master Programmes in the IT & Technology field.

Software Engineering: Software Processes

Course Code: CSEMCSSESP01-01

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

Course Description

Software processes and life cycle models provide a structure for different software engineering tasks. The aim of this module is to provide an understanding of this structure and how to apply it across the entire plan-build-run life cycle. An important foundation for working with software processes is modeling using suitable notation. The different types of life cycles are discussed, including the plan-driven and the agile approaches as well as mixed forms (hybrid models). A special focus is put on the different environments for which these approaches are best suited. Beyond software development, this course also addresses the entire software life cycle, including the operations phase and the cooperation between the two phases, e.g., based on DevOps. Software processes are not just a topic on the level of the individual development group or project but a task for the entire organization; therefore, they should be integrated into overall IT governance and management efforts.

Course Outcomes

On successful completion, students will be able to

- describe the role of software processes and lifecycle models in software engineering from initialization to the withdrawal of a software system.
- describe the notations used for software processes and discuss their relative advantages.
- discuss the differences and commonalities of plan-driven and agile approaches.
- select an appropriate process model for specific application cases and discuss their advantages and disadvantages.
- adapt (tailor-) selected process models to an individual situation.

Contents

1. Foundations of Software Processes
   - 1.1 The Role of Software Processes and Life Cycle Models
   - 1.2 Historical Overview
2. Software Process Definition and Modelling
   - 2.1 Modelling Notations and Meta-Models
   - 2.2 Notations for Modelling the Interaction Between Processes
   - 2.3 Detailed-Level Notations

3. Basic Software Product Life Cycle Models
   - 3.1 Waterfall Models
   - 3.2 The V-Model
   - 3.3 Component or Matrix-Based Models
   - 3.4 Iterative, Incremental and Evolutionary Development

4. Agile and Lean Development Processes
   - 4.1 The Agile Manifesto
   - 4.2 Scrum
   - 4.3 Common Agile Practices
   - 4.4 Kanban and Lean Development
   - 4.5 Scaling Agile Development
   - 4.6 Hybrid Processes

5. The Software Product Life Cycle
   - 5.1 Detailed-Level Process Models: Unified Process and V-Modell XT
   - 5.2 IT Service Management and Operations
   - 5.3 DevOps
   - 5.4 Safety, Security and Privacy

6. Governance and Management of Software Processes
   - 6.1 Process Governance
   - 6.2 Process Design and Deployment
   - 6.3 Process Tailoring
   - 6.4 Process Assessment, Improvement and Measurement
   - 6.5 Tool Support

Literature
Compulsory Reading
Further Reading ▪ Boehm, B. (2006). A view of 20th and 21st century software engineering. ICSE '06: Proceedings of the 28th international conference on software engineering (pp. 12—29). Association for Computing Machinery. ▪ Boehm, B., & Turner, R. (2004). Balancing agility and discipline: A guide for the perplexed. Addison-Wesley Professional. ▪ Kneuper, R. (2018). Software processes and life cycle models: An introduction to modelling, using and managine Agile, plan-driven and hybrid processes. Springer. ▪ Meyer, B. (2014). Agile! The good, the hype and the ugly. Springer. ▪ Schwaber, K., & Sutherland, J. (2020). The scrum guide: The definitive guide to scrum: The rules of the game. Ken Schwaber and Jeff Sutherland.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Written Assessment: Case Study

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Instructional Methods

Learning Material
- ☑ Course Book
- ☑ Video
- ☑ Slides

Exam Preparation
- ☑ Online Tests
- ☑ Guideline

Advanced Mathematics

Module Code: CSEMDSAM-01

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. Robert Graf (Advanced Mathematics)

Contributing Courses to Module

- Advanced Mathematics (CSEMDSAM01-01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies 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 field

Advanced Mathematics

Course Code: CSEMDSAM01-01

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
   - 1.2 Integration
   - 1.3 Partial Differentiation
   - 1.4 Vector Analysis
2. Integral Transformations
   - 2.1 Convolution
   - 2.2 Complex Numbers
   - 2.3 Fourier Series
   - 2.4 Fourier Transformation
3. Vector Algebra

3.1 Scalars and Vectors
3.2 Addition and Subtraction of Vectors
3.3 Multiplication of Vectors, Vector Product, Scalar Product

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

5. Matrices and Vector Spaces
5.1 Basic Matrix Algebra and Systems of Linear Equations
5.2 Transpose, Trace, Determinant, and Inverse of a Matrix
5.3 Eigenvalues, Eigenvectors, and Diagonalization
5.4 Tensors

6. Information Theory
6.1 Mean Squared Error (MSE) and Simple Linear Regression
6.2 Area Under the ROC Curve and Gini Index
6.3 Entropy
6.4 Cross Entropy

Literature

Compulsory Reading

Further Reading

- Mathai, A. M., & Haubold, H. J. (2017). Linear algebra, a course for physicists and engineers (1st ed.) De Gruyter.
- Riley, K. F., Hobson, M. P, & Bence, S. J. (2006). Mathematical methods for physics and engineering (2nd ed.). Cambridge University Press.
- Yang, X.-S. (2018). Mathematics for Civil Engineers: An Introduction. Dunedin Academic Press.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Advanced Statistics

Module Code: CSEMDSAS-01

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	CSEMDSAM01-01	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 (CSEMDSAS01-01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Written Assessment: Written Assignment	

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 field

Advanced Statistics

Course Code: CSEMDSAS01-01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	CSEMDSAM01-01

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 ▪ Bruce, P., & Bruce, A. (2017). Statistics for data scientists: 50 essential concepts. O'Reilley Publishing. ▪ Downey, A. (2013). Think Bayes. O'Reilley Publishing. ▪ Downey, A. (2014). Think stats. O'Reilley Publishing. ▪ McKay, D. (2003). Information theory, inference and learning algorithms. Cambridge University Press. ▪ Reinhart, A. (2015). Statistics done wrong. No Starch Press.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Written Assessment: Written Assignment

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Instructional Methods	
Learning Material	**Exam Preparation**
☑ Course Book	☑ Review Book
☑ Video	☑ Online Tests
☑ Slides	☑ Guideline

Data Science

Module Code: CSEMBDSA1-01

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

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

Module Coordinator

Prof. Dr. Gissel Velarde (Data Science)

Contributing Courses to Module

- Data Science (CSEMBDSA01-01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Introduction to Data Science
- Use Cases and Performance Evaluation
- Pre-processing and Processing of Data
- Selected Mathematical Techniques
- Selected Artificial Intelligence Techniques

Learning Outcomes

Data Science

On successful completion, students will be able to

- identify use cases and evaluate the performance of data-driven approaches.
- understand how domain specific knowledge for a particular application context is required to identify objectives and value propositions for data science use cases.
- appreciate the role and necessity for business-centric model evaluation apposite to the respective area of application.
- comprehend how data are pre-processed in preparation for analysis.
- develop typologies for data and ontologies for knowledge representation.
- decide for appropriate mathematical algorithms to utilize data analysis for a given task.
- understand the value, applicability, and limitations of artificial intelligence for data 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 field of Data Science & Artificial Intelligence	All Master Programmes in the IT & Technology field

Data Science

Course Code: CSEMBDSA01-01

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

Course Description

The course provides the framework to create value from data. After an introduction the course covers how to identify suitable use cases and evaluate the performance of data-driven methods. In an interdisciplinary approach, the requirements from a specific application domain need to be understood and transferred to the technological understanding to identify the objectives and value proposition of a Data Science project. The course covers techniques for the technical processing of data and then introduces advanced mathematical techniques and selected methods from artificial intelligence that are used to analyze data and make predictions.

Course Outcomes

On successful completion, students will be able to

- identify use cases and evaluate the performance of data-driven approaches.
- understand how domain specific knowledge for a particular application context is required to identify objectives and value propositions for data science use cases.
- appreciate the role and necessity for business-centric model evaluation apposite to the respective area of application.
- comprehend how data are pre-processed in preparation for analysis.
- develop typologies for data and ontologies for knowledge representation.
- decide for appropriate mathematical algorithms to utilize data analysis for a given task.
- understand the value, applicability, and limitations of artificial intelligence for data analysis.

Contents

1. Introduction to Data Science
   - 1.1 Overview of Data Science
   - 1.2 Data Science Activities
   - 1.3 Sources and Types of Data
   - 1.4 Stages of Data Processing
   - 1.5 Mathematical Basics for Data Scientists

2. Use Cases and Performance Evaluation
   - 2.1 Data Science Use Cases (DSUCs)
   - 2.2 Model-Centric Evaluation: Performance Metrics
   - 2.3 Business-Centric Evaluation: the Role of KPIs

2.4 Cognitive Biases and Decision-Making Fallacies

3. Pre-Processing of Data
   - 3.1 Transmission of Data
   - 3.2 Data Quality and Cleansing of Data
   - 3.3 Transformation of Data
   - 3.4 Reduction of Data Dimensionality

4. Data Processing
   - 4.1 From Raw Data to Insights
   - 4.2 Data Collection
   - 4.3 Data Analysis and Model Building
   - 4.4 Insight Implementation
   - 4.5 Output Formats of Processed Data
   - 4.6 Data Storage

5. Selected Mathematical Techniques
   - 5.1 Principal component Analysis
   - 5.2 Cluster Analysis
   - 5.3 Linear Regression
   - 5.4 Time Series Forecasting
   - 5.5 Transformation Approaches

6. Selected Artificial Intelligence Techniques
   - 6.1 Support Vector Machines
   - 6.2 Artificial Neural Networks
   - 6.3 Further Approaches

Literature
Compulsory Reading
Further Reading ▪ Akerar, R., & Sajja, P.S. (2016). Intelligent techniques for data science. Cham: Springer. ▪ Bruce, A., & Bruce, P. (2017). Practical statistics for data scientists: 50 essential concepts. Newton, MA: O'Reilly Publishers. ▪ Fawcett, T. & Provost, F. (2013). Data science for business: What you need to know about data mining and data-analytic thinking. Newton, MA: O'Reilly Media. ▪ Hodeghatta, U. R., & Nayak, U. (2017). Business analytics using R – A practical approach. Berkeley, CA: Apress Publishing. (Database: ProQuest). ▪ Liebowitz, J. (2014). Business analytics: An introduction. Boca Raton, FL: Auerbach Publications. (Available online). ▪ Runkler, T. A. (2012). Data analytics: Models and algorithms for intelligent data analysis. Wiesbaden: Springer Vieweg. ▪ Skiena, S. S. (2017). The data science design manual. Cham: Springer.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Project: Software Engineering

Module Code: CSEMCSPSE

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	CSEMCSSESP01-01, CSEMDSPWP01	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. Holger Klus (Project: Software Engineering)

Contributing Courses to Module

- Project: Software Engineering (CSEMCSPSE01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Portfolio	

Weight of Module

see curriculum

Module Contents

- The aim of the course is to apply acquired knowledge to a practical scenario. Project teams work on a project independently over several software process phases.

Learning Outcomes

Project: Software Engineering

On successful completion, students will be able to

- draw from first-hand experience working on a complex, practical project for an industrial software development scenario.
- identify the risks and typical pitfalls of large software projects and make targeted use of risk-minimization strategies.
- apply common techniques in the fields of requirements specification, software design, implementation, and testing.
- conduct a comprehensive project documentation.
- carefully handle project resources.

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 Computer Science & Software Development.	All Master Programmes in the IT & Technology field.

Project: Software Engineering

Course Code: CSEMCSPSE01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	CSEMCSSESP01-01, CSEMDSPWP01

Course Description

In this course, the knowledge students have acquired in prior modules is applied to small- to medium-sized projects. The concrete implementation takes place in group work. The project teams go through important stages of the software life cycle and create the appropriate artifacts (e.g., requirements specification, design, implementation, tests, documentation). Quality assurance of these artifacts is completed by the tutor and students from other project groups. In this way, students learn both the creation and quality assurance of artifacts in a software process.

Course Outcomes

On successful completion, students will be able to

- draw from first-hand experience working on a complex, practical project for an industrial software development scenario.
- identify the risks and typical pitfalls of large software projects and make targeted use of risk-minimization strategies.
- apply common techniques in the fields of requirements specification, software design, implementation, and testing.
- conduct a comprehensive project documentation.
- carefully handle project resources.

Contents

- In software engineering, projects are organized in terms of team member roles (e.g., project manager, quality assurance) and distinct activities (e.g., planning, analysis, implementation) to create software fitting the customer's needs. With respect to the chosen approach (agile or plan-driven), students work through all the typical phases relevant for large projects. They will gain experience regarding organizational concerns like common roles and activities, as well as practical concerns like the creation of requirements specification, design, implementation, tests, and documentation.

Literature
Compulsory Reading
Further Reading ▪ Bass, L., Clements, P., & Kazman, R. (2012). Software architecture in practice (3rd ed.). Boston, MA: Addison-Wesley. ▪ Gruhn, V., & Striemer, R. (Eds.). (2018). The essence of software engineering. Cham: Springer Open. ▪ Martin, R. C. (2008). Clean code: A handbook of agile software craftsmanship. Boston, MA: Pearson. ▪ Martin, R. C. (2017). Clean architecture: A craftsman's guide to software structure and design. Boston, MA: Prentice Hall. ▪ Pohl, K., & Rupp, C. (2015). Requirements engineering fundamentals (2nd ed.). San Rafael, CA: Rocky Nook. ▪ Sommerville, I. (2016). Software engineering (10th ed.). Boston, MA: Pearson.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Portfolio

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
114 h	36 h	0 h	0 h	0 h	150 h

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

Algorithmics

Module Code: CSEMCSA

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. Janki Dodiya (Algorithmics)

Contributing Courses to Module

- Algorithmics (CSEMCSA01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Algorithm design
- Introduction to important classes of algorithms
- Correctness and completeness of algorithms
- Computability and the theoretical limits of algorithms
- Efficiency of algorithms

Learning Outcomes

Algorithmics

On successful completion, students will be able to

- explain the concept of algorithms and its relevance in computing.
- evaluate the correctness of software programs.
- discuss the theoretical and practical limits of software programs.
- select algorithms to solve specific application problems.
- design new algorithms based on standard methods to solve simple application problems.
- analyze and compare algorithms and outline their strengths and weaknesses.

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 Computer Science & Software Development.	All Master Programmes in the IT & Technology field.

Algorithmics

Course Code: CSEMCSA01

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

Course Description

A core activity of computer science and related disciplines is the design, use, and application of algorithms to solve problems. This course introduces common approaches to the design of algorithms, as well as important classes of algorithms that can be used to solve common problems. Performing these tasks successfully requires a thorough understanding of the quality characteristics of algorithms: (partial and total) correctness, accuracy, completeness, and efficiency. At the same time, there are limits to what an algorithm can and should achieve, in theory and in practice, and it is important to realize these limits and take them into account. Apart from algorithms based on standard programming paradigms, there are also various other programming paradigms that lead to other types of algorithms; therefore, this course also provides a short introduction to algorithms for parallel computing, probabilistic algorithms, and quantum algorithms.

Course Outcomes

On successful completion, students will be able to

- explain the concept of algorithms and its relevance in computing.
- evaluate the correctness of software programs.
- discuss the theoretical and practical limits of software programs.
- select algorithms to solve specific application problems.
- design new algorithms based on standard methods to solve simple application problems.
- analyze and compare algorithms and outline their strengths and weaknesses.

Contents

1. Introduction to Algorithms
    - 1.1 Basic Concepts and Historical Overview
    - 1.2 Algorithms, Programming Languages and Data Structures
    - 1.3 Quality Algorithms: Correctness, Accuracy, Completeness, Efficiency
    - 1.4 The Role of Algorithms in Society
2. Algorithm Design
    - 2.1 Data Structures
    - 2.2 Recursion and Iteration
    - 2.3 Divide-and-Conquer

2.4 Balancing, Greedy Algorithms, and Dynamic Programming

3. Some Important Algorithms
   - 3.1 Sorting and Searching
   - 3.2 Pattern-Matching
   - 3.3 The RSA Algorithm
   - 3.4 The k-Means Algorithm for Data Clustering

4. Correctness, Accuracy, and Completeness of Algorithms
   - 4.1 Partial Correctness
   - 4.2 Total Correctness
   - 4.3 Ensuring Correctness in Day-to-Day Programming
   - 4.4 Accuracy, Approximation, and Error Analysis

5. Computability
   - 5.1 Models of Computation
   - 5.2 The Halting Problem
   - 5.3 Undecidable Problems

6. Efficiency of Algorithms: Complexity Theory
   - 6.1 Models of Complexity
   - 6.2 NP-Completeness
   - 6.3 P=NP?

7. Advanced Algorithmics
   - 7.1 Parallel Computing
   - 7.2 Probabilistic Algorithms

Literature

Compulsory Reading

Further Reading

- Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2013). Introduction to algorithms (3rd ed.). Cambridge, MA: MIT Press.
- Dewdney, A. K. (2001). The new turing omnibus. London: Macmillan Education.
- Harel, D. (2014). Algorithmics: The spirit of computing (3rd ed.). Berlin, Heidelberg: Springer.
- Sedgewick, A., & Wayne, K. (2011). Algorithms (4th ed.). Boston, MA: Pearson Education.
- Skiena, S. S. (2012). The algorithm design manual (2nd ed.). London: Springer.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Cyber Security and Data Protection

Module Code: CSEMCSITSDP-01

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. Ralf Kneuper (Cyber Security and Data Protection)

Contributing Courses to Module

- Cyber Security and Data Protection (CSEMCSITSDP01-01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Written Assignment: Case Study	

Weight of Module

see curriculum

Module Contents

- Data protection and privacy
- Cyber security building blocks
- Cyber security management
- Cryptography concepts
- Cryptography applications

Learning Outcomes

Cyber Security and Data Protection

On successful completion, students will be able to

- explain the core concepts of cyber security, data protection, and cryptography including their differences and relationships.
- compare the approaches to data protection within in different legal systems.
- apply data protection concepts to data science and other application scenarios.
- analyze application scenarios to identify the adequate cyber security management measures that should be implemented.
- explain the different approaches to data protection in different cultures.

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 Computer Science & Software Development	All Master Programmes in the IT & Technology field

Cyber Security and Data Protection

Course Code: CSEMCSITSDP01-01

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

Course Description

With the increasing digitization and networking of IT systems, the need for safeguarding systems and the data processed by these systems has grown. The aim of this module is to provide an understanding of security measures needed, cyber security including cryptography, and data protection. While the need for cyber security is similar around the world, different cultures have different expectations regarding data protection and privacy. Nevertheless, personal data are often processed outside the country where the affected individuals live. Hence, the cultural aspects of data protection need to be taken into account wherever the data are processed. This course provides an overview of the main cyber security measures in different application scenarios, as well as their integration into an Information Security Management System, with particular focus on the relevant ISO/IEC 270xx family of standards. Cryptography provides an important tool set for cyber security and is used in many different application scenarios such as secure Internet protocols and block chain.

Course Outcomes

On successful completion, students will be able to

- explain the core concepts of cyber security, data protection, and cryptography including their differences and relationships.
- compare the approaches to data protection within in different legal systems.
- apply data protection concepts to data science and other application scenarios.
- analyze application scenarios to identify the adequate cyber security management measures that should be implemented.
- explain the different approaches to data protection in different cultures.

Contents

1. Foundations of Data Protection and Cyber Security
    - 1.1 Terminology and Risk Management
    - 1.2 Core Concepts of Cyber Security
    - 1.3 Core Concepts of Data Protection and Privacy
    - 1.4 Core Concepts of Cryptography
    - 1.5 Legal Aspects
2. Data Protection

- 2.1 Basic Concepts of Data Protection (ISO/IEC 29100, Privacy by Design)
- 2.2 Data Protection in Europe: the GDPR
- 2.3 Data Protection in the USA
- 2.4 Data Protection in Asia

3. Applying Data Protection
   - 3.1 Anonymity and Pseudonyms (k-Anonymity, i-Diversity, Differential Privacy)
   - 3.2 Data Protection in Data Science and Big Data
   - 3.3 User Tracking in Online Marketing
   - 3.4 Cloud Computing

4. Building Blocks of Cyber Security
   - 4.1 Authentication, Access Management and Control
   - 4.2 Cyber Security in Networks
   - 4.3 Developing Secure IT Systems (OWASP, etc.)

5. Cyber Security Management
   - 5.1 Security Policy
   - 5.2 Security and Risk Analysis
   - 5.3 The ISO 270xx Series
   - 5.4 IT Security and IT Governance
   - 5.5 Example: Cyber Security for Credit Cards (PCI DSS)

6. Cryptography
   - 6.1 Symmetric Cryptography
   - 6.2 Asymmetric Cryptography
   - 6.3 Hash Functions
   - 6.4 Secure Data Exchange (Diffie-Hellman, Perfect Forward Secrecy, etc.)

7. Cryptographic Applications
   - 7.1 Digital Signatures
   - 7.2 Electronic Money
   - 7.3 Secure Internet Protocols (TLS, IPSec, etc.)
   - 7.4 Block Chain

Literature
Compulsory Reading
Further Reading ▪ Amoroso, E., & Amoroso, M. (2017). From CIA to APT: An introduction to cyber security. Independently published. ▪ National Institute of Standards and Technology. (2018). Framework for improving critical infrastructure cybersecurity. ▪ Paar, C., & Pelzl, J. (2011). Understanding cryptography: A textbook for students and practitioners. Springer. ▪ Walker, B. (2019). Cyber security comprehensive beginners guide to learn the basics and effective methods of cyber security. Independently published.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assignment: Case Study

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
94 h	36 h	0 h	20 h	0 h	150 h

Seminar: Computer Science and Society

Module Code: CSEMCSSCSAS

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

Johannes Kent Walter (Seminar: Computer Science and Society)

Contributing Courses to Module

- Seminar: Computer Science and Society (CSEMCSSCSAS01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Written Assessment: Research Essay	

Weight of Module

see curriculum

Module Contents

- The seminar covers the relationship between computer science and society, including topics such as the social responsibility of computer scientists and the effects of digitization on society. Based on a list of topics updated regularly, students select or are assigned a specific topic on which to write a scientific report.

Learning Outcomes

Seminar: Computer Science and Society

On successful completion, students will be able to

- name the main questions regarding the relationship between computer science and society.
- discuss selected topics regarding the relationship between computer science and society.
- analyze one aspect of the relationship between computer science and society in detail.
- take selected topics and case studies and link them with well-known concepts, as well as critically question and discuss them.
- transfer theoretically acquired knowledge to a specific context.
- edit scientifically a select 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 Computer Science & Software Development.	All Master Programmes in the IT & Technology field.

Seminar: Computer Science and Society

Course Code: CSEMCSSCSAS01

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

Course Description

The seminar covers the relationship between computer science and society. Over the past several decades, computer science has greatly changed society, and it is important that prospective computer scientists think about the effects of computer science on society and take these influences into account in their work. Typical topics to be addressed include, for example, the effects of ethics and professionalism in computing, the responsibility of computer scientists, the effects of data science and social networks on society, surveillance, and dual use of IT.

Course Outcomes

On successful completion, students will be able to

- name the main questions regarding the relationship between computer science and society.
- discuss selected topics regarding the relationship between computer science and society.
- analyze one aspect of the relationship between computer science and society in detail.
- take selected topics and case studies and link them with well-known concepts, as well as critically question and discuss them.
- transfer theoretically acquired knowledge to a specific context.
- edit scientifically a select topic.

Contents

- The seminar covers different topics regarding the relationship between computer science and society. Each participant must create a seminar paper on a topic assigned to him/her and present the contents of the written paper.

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 Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
114 h	36 h	0 h	0 h	0 h	150 h

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

Artificial Intelligence

Module Code: CSEMAIAI

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. Claudia Heß (Artificial Intelligence)

Contributing Courses to Module

- Artificial Intelligence (CSEMAIAI01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies 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 Master Programmes in the IT & Technology field

Artificial Intelligence

Course Code: CSEMAIAI01

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 Winters
   - 1.3 Notable Advances in Artificial Intelligence
2. Early Systems in Artificial Intelligence
   - 2.1 Overview of Expert Systems
   - 2.2 Introduction to Prolog
   - 2.3 Pattern Recognition and Machine Learning (ML)
   - 2.4 Use Cases

3. Neuroscience and Cognitive Science
   - 3.1 Neuroscience and the Human Brain
   - 3.2 Cognitive Science
   - 3.3 The Relationship Between Neuroscience, Cognitive Science, and Artificial Intelligence

4. Modern Artificial Intelligence Systems
   - 4.1 Recent Developments in Hardware and Software
   - 4.2 Narrow versus General Artificial Intelligence
   - 4.3 Natural Language Processing (NLP) and Computer Vision

5. Applications of Artificial Intelligence
   - 5.1 Mobility and Autonomous Vehicles
   - 5.2 Personalized Medicine
   - 5.3 FinTech
   - 5.4 Retail and Industry

Literature

Compulsory Reading

Further Reading

- Chowdhary, K. R. (2020). Fundamentals of Artificial Intelligence. Springer India.
- Russell, S. & Norvig, P. (2022). Artificial intelligence. A modern approach (4th ed.). Pearson Education.
- Ward, J. (2020). The student's guide to cognitive neuroscience. (4th ed.). Taylor & Francis Group.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Big Data Technologies

Module Code: CSEMDSBDT-01

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. Christian Müller-Kett (Big Data Technologies)

Contributing Courses to Module

- Big Data Technologies (CSEMDSBDT01-01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Data types and data sources
- Databases
- Modern storage frameworks
- Data formats
- Distributed computing

Learning Outcomes

Big Data Technologies

On successful completion, students will be able to

- identify different types and sources of data.
- understand different database concepts.
- learn to build new database structures.
- evaluate various data storage frameworks w.r.t. project requirements.
- analyze which data format to use for a given project.
- understand what roles you could take in such projects.
- create a distributed computing environment for a given project.
- understand the ethical impact of big data technology choices.

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.

Big Data Technologies

Course Code: CSEMDSBDT01-01

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

Course Description

Data are often considered the “new oil”, the raw material from which value is created. To harness the power of data, the data need to be stored and processed on a technical level. This course introduces the four “Vs” of data, as well as typical data sources and types. This course then discusses how data are stored in databases. Particular focus is given to database structures and different types of databases, e.g., relational, noSQL, NewSQL, and time-series.Beyond classical and modern databases, this course covers a wide range of storage frameworks such as distributed filesystems, streaming, and query frameworks. This is complemented by a detailed discussion of data storage formats ranging from classical approaches such as CSV and HDF5 to more modern approaches like Apache Arrow and Parquet.Finally, this course gives an overview of distributed computing environments based on local clusters, cloud computing facilities, and container-based approaches.

Course Outcomes

On successful completion, students will be able to

- identify different types and sources of data.
- understand different database concepts.
- learn to build new database structures.
- evaluate various data storage frameworks w.r.t. project requirements.
- analyze which data format to use for a given project.
- understand what roles you could take in such projects.
- create a distributed computing environment for a given project.
- understand the ethical impact of big data technology choices.

Contents

1. Data Types and Data Sources
    - 1.1 The 4Vs of data: volume, velocity, variety, veracity
    - 1.2 Data sources
    - 1.3 Data types
2. Databases
    - 2.1 Database structures
    - 2.2 Introduction to SQL

2.3 Relational databases
2.4 nonSQL, NewSQL databases
2.5 Timeseries DB

3. Modern data storage frameworks
   3.1 Distributed Filesystems
   3.2 Streaming frameworks
   3.3 Query frameworks

4. Data formats
   4.1 Traditional data exchange formats
   4.2 Apache Arrow
   4.3 Apache Parquet

5. Distributed Computing
   5.1 Cluster-based approaches
   5.2 Containers
   5.3 Cloud-based approaches

Literature
Compulsory Reading
Further Reading ▪ Date, C. J. (2003). An introduction to database systems. Pearson. ▪ Kleppmann, M. (2017). Designing data-intensive applications. O'Reilly. ▪ Wiese, L. (2015). Advanced data management. De Gruyter.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Project: Computer Science

Module Code: CSEMCSPCSP

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. Holger Klus (Project: Computer Science)

Contributing Courses to Module

- Project: Computer Science (CSEMCSPCSP01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Portfolio	

Weight of Module

see curriculum

Module Contents

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

Learning Outcomes

Project: Computer Science

On successful completion, students will be able to

- apply the concepts of computer science to real-world problems.
- translate learned theories into practice in the field of computer science.
- analyze a real-world problem and design a computer science solution for it.
- explain their portfolio work and its scientific background.
- produce adequate documentation for their work.

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 Computer Science & Software Development.	All Master Programmes in the IT & Technology field.

Project: Computer Science

Course Code: CSEMCSPCSP01

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

Course Description

Students will define a portfolio project in which they will be able to apply the knowledge in the field of computer science they have learned in previous courses. Students create the portfolio project and document the results, reflecting on applied computer science concepts and their influence on the success of the portfolio project.

Course Outcomes

On successful completion, students will be able to

- apply the concepts of computer science to real-world problems.
- translate learned theories into practice in the field of computer science.
- analyze a real-world problem and design a computer science solution for it.
- explain their portfolio work and its scientific background.
- produce adequate documentation for their work.

Contents

- In this course, students create a portfolio in which they apply the topics covered in the previous modules in this degree program.

Literature

Compulsory Reading

Further Reading

- Hintzbergen, J., Hintzberger, K., Smulders, A., & Baars, H. (2015). Foundations of information security. Based on ISO 27001 and ISO 27002. Zaltbommel: Van Haren Publishing.
- Phillips, J. (2010). IT project management: On track from start to finish (3rd ed.). New York, NY: McGraw-Hill.
- Sedgewick, R., & Wayne, K. (2016). Computer science: An interdisciplinary approach. Boston, MA: Addison-Wesley.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Portfolio

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
114 h	36 h	0 h	0 h	0 h	150 h

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

Seminar: Current Topics in Computer Science

Module Code: CSEMCSSCTCS

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. Janki Dodiya (Seminar: Current Topics in Computer Science)

Contributing Courses to Module

- Seminar: Current Topics in Computer Science (CSEMCSSCTCS01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Written Assessment: Research Essay	

Weight of Module

see curriculum

Module Contents

- This seminar deals with current topics of computer science. Students make a dive deep into a specific topic within a sub-discipline of their choice. These disciplines are including but not limited to the following: artificial intelligence, big data technologies, IT security and data protection, algorithmics, data science, and programming.

Learning Outcomes

Seminar: Current Topics in Computer Science

On successful completion, students will be able to

- name current and relevant topics in the sub-disciplines of computer science.
- give examples of the influence of computer science on current developments.
- transfer theoretical knowledge to real case studies.
- translate learned theories into practical application in the computer science field.
- write about a select computer science topic in a scientific manner.
- critically question and discuss current problems in computer science.
- adapt sub-discipline-specific models and frameworks for use in solving practical 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 of Computer Science & Software Development.	All Bachelor Programmes in the IT & Technology field.

Seminar: Current Topics in Computer Science

Course Code: CSEMCSSCTCS01

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

Course Description

This seminar is an opportunity for students to deepen the broad knowledge they will have gained over the previous four semesters of the study program. Students will choose a topic of specific individual interest that is connected to a sub-discipline of computer science. If a student, for example, is interested in the application of artificial intelligence in a specific context, elaborating context-specific use cases from a literature review can be the theme of the essay. Feedback provided by the tutor will help students strengthen any weaknesses they may have in scientific writing and academic work and prepare students for writing their master thesis.

Course Outcomes

On successful completion, students will be able to

- name current and relevant topics in the sub-disciplines of computer science.
- give examples of the influence of computer science on current developments.
- transfer theoretical knowledge to real case studies.
- translate learned theories into practical application in the computer science field.
- write about a select computer science topic in a scientific manner.
- critically question and discuss current problems in computer science.
- adapt sub-discipline-specific models and frameworks for use in solving practical problems.

Contents

- Computer science is a broad subject area with many very different facets, depending on the specific sub-discipline. This seminar will address this diversity by taking up current trends in the context of individually-prepared texts. Each participant must create an essay for this purpose. Possible topics include artificial intelligence, big data technologies, IT security and data protection, algorithmics, data science, and programming.

Literature
Compulsory Reading
Further Reading ▪ Brookshear, G., & Bylow, D. (2014). Computer science: An overview (12th ed.). Boston, MA: Pearson. ▪ Gruhn, V., & Striemer, R. (Eds.). (2018). The essence of software engineering. Cham: Springer. ▪ Springer. (n.d.) Lecture Notes in Computer Science. Heidelberg: Springer. ▪ Tardos, E. (Ed.). (n.d.) Journal of the ACM.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	Mandatory attendance of at least 60% of the lectures
Type of Exam	Written Assessment: Research Essay

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
114 h	36 h	0 h	0 h	0 h	150 h

Networks and Distributed Systems

Module Code: CSEMCSNDS

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. Jetzabel Maritza Serna-Olvera (Networks and Distributed Systems)

Contributing Courses to Module

- Networks and Distributed Systems (CSEMCSNDS01)

Module Exam Type

Module Exam	Split Exam
Study Format: Campus Studies Exam, 90 Minutes	

Weight of Module

see curriculum

Module Contents

- Communication Networks
- Communication Protocols
- Distributed System Architectures
- Distributed Algorithms and Applications

Learning Outcomes

Networks and Distributed Systems

On successful completion, students will be able to

- explain the basic concepts of digital data transmission and computer networks.
- detail the ISO/OSI reference model and characterize aspects of its different layers.
- compare the ISO/OSI model to the TCP/IP protocol stack, its services, and its applications.
- elaborate on different approaches and architectures for distributed systems.
- describe the challenges and opportunities of distributed algorithms and applications.
- analyze different aspects of decentralized, mobile, and pervasive computing.

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 Computer Science & Software Development.	All Bachelor Programmes in the IT & Technology field.

Networks and Distributed Systems

Course Code: CSEMCSNDS01

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

Course Description

Isolated computer systems are becoming the exception, with modern systems typically connected to each other via networks. Through these networks, data is constantly exchanged via the internet using communication protocols. These allow modern computers to access data and functions from other computer systems, enabling distributed systems. In this distributed Systems algorithms and applications are partially mapped to different entities within the network to perform shared computing tasks. The knowledge transfer regarding the required technologies, architectures, and algorithms for doing so is the focus of this course.

Course Outcomes

On successful completion, students will be able to

- explain the basic concepts of digital data transmission and computer networks.
- detail the ISO/OSI reference model and characterize aspects of its different layers.
- compare the ISO/OSI model to the TCP/IP protocol stack, its services, and its applications.
- elaborate on different approaches and architectures for distributed systems.
- describe the challenges and opportunities of distributed algorithms and applications.
- analyze different aspects of decentralized, mobile, and pervasive computing.

Contents

1. Computer Networks
   - 1.1 Basic Concepts of Digital Data Transmission
   - 1.2 Network Topologies and Interconnections
   - 1.3 Basics of Communication Engineering and Coding Theory
   - 1.4 The Physical Layer: Transmission Methods and Media
2. Communication Protocols
   - 2.1 The ISO/OSI Reference Model
   - 2.2 The Data Link Layer: Standards and Technologies
   - 2.3 The Network Layer: Addressing and Routing
   - 2.4 The Transport Layer: Reliability and Flow Control
3. The Internet Protocol Suite

- 3.1 History of the Internet and the World Wide Web
- 3.2 The TCP/IP Reference Model and Protocol Stack
- 3.3 Examples of Internet Protocols and Services
- 3.4 Security Aspects of Communication on the Internet

4. Architectures of Distributed Systems
   - 4.1 Client-Server Architectures
   - 4.2 Service-Oriented Architectures, Web- and Micro-Services
   - 4.3 Edge and Cloud Computing
   - 4.4 Peer-to-Peer Computing

5. Distributed Algorithms and Applications
   - 5.1 Communication and Synchronization in Distributed Systems
   - 5.2 Distributed Algorithms (Concurrency and Parallel Processing)
   - 5.3 Transactions and Data Management (Consistency and Replication)
   - 5.4 Security Aspects for Distributed Services and Applications

6. From Distributed Systems to Ubiquitous Computing
   - 6.1 Distributed Ledger Technology
   - 6.2 Aspects of Mobile Computing
   - 6.3 Aspects of Pervasive Computing and the Internet of Things

Literature

Compulsory Reading

Further Reading

- Comer, D. E. (2015). Computer networks and internets (global ed., 6th ed.). Pearson Education.
- Comer, D. E. (2018). The internet book: Everything you need to know about computer networking and how the internet works (5th ed.). CRC Press.
- Kurose, J., & Keith R. (2017). Computer networking: A top-down approach, global edition (7th ed.). Pearson Education.
- Tanenbaum, A. S., & Wetherall, D. J. (2011). Computer networks: New international edition (5th ed.). Pearson Education.
- Van Steen, M., & Tanenbaum, A. S. (2017). Distributed systems (3rd ed.). CreateSpace Independent Publishing Platform.

Study Format Campus Studies

Study Format	Course Type
Campus Studies	Campus Lecture

Information about the examination	
Examination Admission Requirements	
Type of Exam	Exam, 90 Minutes

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
84 h	36 h	0 h	30 h	0 h	150 h

Instructional Methods

Learning Material
- ☑ Course Book
- ☑ Video
- ☑ Slides

Exam Preparation
- ☑ Practice Exam
- ☑ Online Tests

Advanced Cyber Security and Cryptology

Module Code: DLMCSEAITSC-01

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		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. Alexander Lawall (Seminar: Advanced Cyber Security) / Prof. Dr. Björn Kaidel (Cryptology)

Contributing Courses to Module

- Seminar: Advanced Cyber Security (DLMCSEAITSC01)
- Cryptology (DLMCSEAITSC02-01)

Module Exam Type

Module Exam	Split Exam
	Seminar: Advanced Cyber Security • Study Format "Distance Learning": Written Assessment: Research Essay Cryptology • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

Seminar: Advanced Cyber Security

- This course covers selected advanced topics in cyber security, including the closely related topics of data protection and cryptology, and discusses them in detail. Based on a list of topics updated regularly, students select or are assigned a specific topic about which they write a scientific research essay.

Cryptology

- Basic Concepts of Cryptology
- Symmetric Cryptosystems
- Asymmetric Cryptosystems
- Authentication
- Cryptanalysis
- Cryptology and the Internet
- Practical Aspects of Cryptology
- Applications

Learning Outcomes

Seminar: Advanced Cyber Security

On successful completion, students will be able to

- analyze and describe one aspect of cyber security in detail.
- independently analyze selected topics in cyber security and link them with well-known concepts, as well as critically question and discuss them.
- transfer theoretically-acquired knowledge to a specific context.
- write and edit a scientific essay on a relevant select topic.

Cryptology

On successful completion, students will be able to

- discuss the main cryptographic systems and algorithms and their relevance in IT today.
- discuss the security of internet-based applications.
- evaluate different cryptographic systems and algorithms to select an appropriate solution for real-world problems in IT.
- apply standard cryptographic systems and algorithms to solve real-world problems in IT.
- appraise existing cryptographic solutions to real-world problems and identify major weaknesses where relevant.

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 Computer Science & Software Development	All Master Programmes in the IT & Technology field

Seminar: Advanced Cyber Security

Course Code: DLMCSEAITSC01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	CSEMCSITSDP01-01 or DLMCSITSDS01

Course Description

This seminar covers advanced topics in cyber security. With the growth of the internet and digitization, cyber security has become an increasingly important topic and needs to be taken into account in the development and setup of software and IT systems. Typical topics that may be addressed include the analysis of selected aspects of information security management systems according to the ISO 27000 series; the use of cyber security to support data protection; and the detailed analysis and description of certain algorithms or cryptosystems.

Course Outcomes

On successful completion, students will be able to

- analyze and describe one aspect of cyber security in detail.
- independently analyze selected topics in cyber security and link them with well-known concepts, as well as critically question and discuss them.
- transfer theoretically-acquired knowledge to a specific context.
- write and edit a scientific essay on a relevant select topic.

Contents

- The seminar covers different advanced topics regarding cyber security. Each participant must prepare a research essay 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 Distance Learning

Study Format	Course Type
Distance Learning	Seminar

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

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

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

Cryptology

Course Code: DLMCSEAITSC02-01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	CSEMCSITSDP01-01 or DLMCSITSDS01

Course Description

The focus of this course is to provide a thorough introduction to cryptology and its main sub-disciplines cryptography and cryptanalysis. Particular emphasis is put on the use of cryptology to support the security of IT systems. In the first part of the courses, students gain a solid understanding of the basic concepts of cryptology, in particular symmetric and asymmetric cryptosystems, authentication, and common approaches to break these cryptosystems using cryptanalysis. Based on this foundational understanding, the course goes on to cover the practical use of cryptology, starting with an introduction to the standard protocols and techniques used to ensure the security of communication via the internet. Next, practical aspects of applying cryptographic techniques and algorithms are covered, such as their long-term security. Finally, some application examples show how the concepts of cryptology are commonly used and can be used to solve challenges such as online banking.

Course Outcomes

On successful completion, students will be able to

- discuss the main cryptographic systems and algorithms and their relevance in IT today.
- discuss the security of internet-based applications.
- evaluate different cryptographic systems and algorithms to select an appropriate solution for real-world problems in IT.
- apply standard cryptographic systems and algorithms to solve real-world problems in IT.
- appraise existing cryptographic solutions to real-world problems and identify major weaknesses where relevant.

Contents

1. Basic Concepts of Cryptology
    - 1.1 Introduction and Terminology
    - 1.2 IT Security, Threats and Common Attacks
    - 1.3 Historical Overview
    - 1.4 Security Criteria
    - 1.5 Hash Functions
2. Symmetric Cryptosystems
    - 2.1 Substitution and Transposition

- 2.2 Stream and Block Ciphers
- 2.3 Digital Encryption Standard (DES)
- 2.4 Advanced Encryption Standard (AES)
- 2.5 Cryptographic Hash Functions
- 2.6 Message Authentication Codes

3. Asymmetric Cryptosystems
   - 3.1 The RSA Schemes
   - 3.2 Elliptic Curves
   - 3.3 Digital Signatures
   - 3.4 The Diffie-Hellman Key Exchange
   - 3.5 Key Exchange and Public Key Infrastructures

4. Authentication
   - 4.1 Passwords
   - 4.2 Challenge-Response and Zero-Knowledge
   - 4.3 Biometrics-Based Authentication
   - 4.4 Authentication in Distributed Systems
   - 4.5 Smartcards
   - 4.6 Identity and Anonymity

5. Cryptanalysis
   - 5.1 Frequency Analysis
   - 5.2 Brute-Force Attacks
   - 5.3 Rainbow Tables
   - 5.4 Security Models
   - 5.5 Side-Channel Attacks
   - 5.6 Modern Cryptanalytic Algorithms

6. Cryptology and the Internet
   - 6.1 Internet Protocols
   - 6.2 IPSec
   - 6.3 Transport Layer Security
   - 6.4 Secure E-Mail
   - 6.5 Secure DNS

7. Practical Aspects of Cryptology
   - 7.1 Random Number Generation

7.2 Long-Term Security
7.3 Incorporating Cryptography into Application Development
7.4 Legal and Regulatory Aspects

8. Applications
8.1 Online Banking
8.2 Blockchain
8.3 Voting
8.4 Steganography and Watermarks
8.5 The Tor Project

Literature

Compulsory Reading

Further Reading

- Esslinger, B. (2010). The CrypTool script: Cryptography, mathematics, and more (10th ed.). CrypTool Development Team.
- Katz, J., & Lindell, Y. (2014). Introduction to modern cryptography (2nd ed.). Chapman and Hall/CRC.
- Menezes, A. J., van Oorschot, P. C., & Vanstone, S. A. (2015). Handbook of applied cryptography. CRC Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Blockchain and Quantum Computing

Module Code: DLMCSEBCQC

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. David Florysiak (Blockchain) / Prof. Dr. Simon Martin (Quantum Computing)

Contributing Courses to Module

- Blockchain (DLMCSEBCQC01)
- Quantum Computing (DLMCSEBCQC02)

Module Exam Type

Module Exam	Split Exam
	Blockchain • Study Format "Distance Learning": Written Assessment: Written Assignment Quantum Computing • Study Format "Distance Learning": Oral Assignment

Weight of Module

see curriculum

Module Contents

Blockchain

- Basic concepts of blockchain and related technologies
- Applications of blockchain and DLT
- Security
- Development of blockchain and DLT applications
- Social and legal aspects

Quantum Computing

- Physics of quantum computing
- Quantum computing models
- Quantum algorithms
- Quantum computing with the IBM framework Qiskit
- Applications, potential for and challenges of quantum computing

Learning Outcomes

Blockchain

On successful completion, students will be able to

- outline the functions provided by and the technology used in blockchains.
- explain important applications of block chains, in particular BitCoin.
- demonstrate the technical architecture of blockchain applications.
- appraise the benefits and challenges of suggested blockchain applications.
- discuss the social and legal aspects of blockchain technology.

Quantum Computing

On successful completion, students will be able to

- outline the basic concepts of quantum mechanics as they relate to quantum computing.
- describe the computation models used in quantum computing.
- demonstrate the role of quantum computing for cryptography and other application areas.
- compare the theoretical and practical potential of quantum computing to classical computing.
- apply the concepts of quantum computing to develop simple programs within the Qiskit framework.

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 Computer Science & Software Development.	All Bachelor Programmes in the IT & Technology field.

Blockchain

Course Code: DLMCSEBCQC01

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

Course Description

Started by the cryptocurrency BitCoin, blockchain and related topics such as distributed ledger technologies and smart contracts have become increasingly important over the last few years and are claimed to be a major disruptive technologies. As BitCoin shows, systems that today need a trustworthy central coordinating body may become genuinely distributed systems without the need for such a body in the future. While blockchain has the potential for completely new types of applications, these suggested applications do not always make use of the strengths of the technology; rather, they simply provide a different approach to solving problems that could be solved more easily and efficiently using standard technologies such as database systems. Furthermore, blockchain applications have led to new social challenges and legal questions, such as the legal status of "smart contracts". Different infrastructures such as Ethereum and Hyperledger have been developed to form the basis for blockchain applications. The goal of this course is to provide an understanding of the technical, as well as social and legal, aspects of blockchain and related technologies.

Course Outcomes

On successful completion, students will be able to

- outline the functions provided by and the technology used in blockchains.
- explain important applications of block chains, in particular BitCoin.
- demonstrate the technical architecture of blockchain applications.
- appraise the benefits and challenges of suggested blockchain applications.
- discuss the social and legal aspects of blockchain technology.

Contents

1. Basic Concepts
   - 1.1 The Functional View: Distributed Ledger Technologies
   - 1.2 The Technical View: Blockchain
   - 1.3 History of Blockchain and DLT
   - 1.4 Consense Mechanisms
2. BitCoin
   - 2.1 The BitCoin Payment System
   - 2.2 The Technology Behind BitCoin

- 2.3 Security of BitCoin
- 2.4 Scalability and Other Limitations of BitCoin
- 2.5 BitCoin Derivatives and Alternatives

3. Smart Contracts and Decentralized Apps
   - 3.1 Smart Contracts
   - 3.2 Decentralized Apps (DApps)
   - 3.3 Ethereum
   - 3.4 Hyperledger
   - 3.5 Alternative Platforms for Smart Contracts and DApps

4. Security of Block Chain and DLT
   - 4.1 Cryptology Used
   - 4.2 Attacks on Blockchain and DLT
   - 4.3 Resolving Bugs and Security Holes
   - 4.4 Long-Term Security

5. Block Chain and DLT Application Scenarios
   - 5.1 Benefits and Limits of Applying Blockchain and DLT
   - 5.2 Registers for Land and Other Property
   - 5.3 Applications in the Supply Chain
   - 5.4 Applications in Insurance
   - 5.5 Initial Coin Offerings for Sourcing Capital
   - 5.6 Examples of Further Applications

6. Development of Blockchain and DLT Applications
   - 6.1 Architecture of Blockchain and DLT Applications
   - 6.2 Platform Selection
   - 6.3 Design of Blockchain and DLT Applications

7. Blockchain and Society
   - 7.1 (Mis-)Trust in Institutions
   - 7.2 Blockchain and the Environment
   - 7.3 Cyber-Currencies in the Darknet
   - 7.4 ICO Fraud

8. Legal Aspects
   - 8.1 DLT and Smart Contracts as Legal Contracts
   - 8.2 Cryptocurrencies as Legal Currencies

8.3 Regulation of ICOs
8.4 Data Protection / Privacy in Blockchains

Literature

Compulsory Reading

Further Reading

- De Filippi, P., & Wright, A. (2018). Blockchain and the law. The rule of code. Cambridge, MA: Harvard University Press.
- Meinel, C., Gayvoronskaya, T. & Schnjakin, M. (2018). Blockchain. Hype or innovation. Potsdam: Universitätsverlag Potsdam.
- Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system [white paper]. Retrieved from https://bitcoin.org/bitcoin.pdf
- Tapscott, D., & Tapscott, N. (2018). Blockchain revolution. How the technology behind bitcoin is changing money, business, and the world. New York, NY: Portfolio/Penguin.
- Xu, W., Weber, I., & Staples, M. (2019). Architecture for blockchain applications. Cham: Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Quantum Computing

Course Code: DLMCSEBCQC02

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

Course Description

Quantum computing is a completely new paradigm for the architecture of computers. It currently is in the early stage of development but has the potential to speed up certain kinds of computations, not just by orders of magnitude but by moving them from exponential to linear growth. One of the issues that will be affected is the prime factorization of large numbers which currently forms the basis for important cryptographic algorithms, in particular the RSA algorithm which would in that case would no longer be secure. This course gives an introduction to the physics behind quantum computing and the computation models used. Students are familiarized with the most important algorithms for quantum computing and write a few programs for quantum computers. The application potential and challenges of quantum computing are also discussed.

Course Outcomes

On successful completion, students will be able to

- outline the basic concepts of quantum mechanics as they relate to quantum computing.
- describe the computation models used in quantum computing.
- demonstrate the role of quantum computing for cryptography and other application areas.
- compare the theoretical and practical potential of quantum computing to classical computing.
- apply the concepts of quantum computing to develop simple programs within the Qiskit framework.

Contents

1. Basic concepts
    - 1.1 Quantum physics as a basis for computing
    - 1.2 Types of quantum computers
    - 1.3 Qbits
    - 1.4 Linear algebra
2. The physics of quantum computers
    - 2.1 Basic concepts of quantum mechanics
    - 2.2 Spin and entanglement
    - 2.3 Architecture of quantum computers

2.4 Noise and error correction
2.5 Current state and outlook

3. Quantum computing models
   3.1 Quantum gates and circuits
   3.2 Single qubit quantum systems
   3.3 Multiple qubit quantum systems

4. Quantum algorithms
   4.1 Computability and complexity in quantum computing
   4.2 Quantum Fourier transform
   4.3 The Shor algorithm
   4.4 The Grover algorithm

5. Quantum computing with the IBM framework Qiskit
   5.1 Overview of Qiskit and the IBM Q Provider
   5.2 Quantum circuits in Qiskit
   5.3 First steps in programming with Qiskit

6. Applications, potential and challenges of quantum computing
   6.1 Applications of quantum computing
   6.2 Quantum cryptography and post-quantum cryptography
   6.3 Quantum supremacy

Literature

Compulsory Reading

Further Reading

- Mermin, N. D. (2007). Quantum computer science: An introduction. Cambridge University Press.
- Nielsen, M. A., & Chuang, I. L. (2000). Quantum computation and quantum information. Cambridge University Press.
- Rieffel, E. G., & Polak, W. H. (2011). Quantum computing: A gentle introduction. MIT Press.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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

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

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

IT Governance and Service Management

Module Code: DLMBITGSM

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. André Köhler (IT Service Management) / Prof. Dr. Brian Gannon (IT Governance and Compliance)

Contributing Courses to Module

- IT Service Management (DLMBITGSM01)
- IT Governance and Compliance (DLMBITGSM02)

Module Exam Type

Module Exam	Split Exam
	IT Service Management • Study Format "Distance Learning": Exam, 90 Minutes • IT Governance and Compliance • Study Format "Distance Learning": Exam, 90 Minutes

Weight of Module

see curriculum

Module Contents

IT Service Management

- IT infrastructure library (ITIL)
- ITIL service strategy
- ITIL service design
- ITIL service transition
- ITIL service operation

IT Governance and Compliance

- Establishing IT governance and compliance
- COBIT framework
- IT governance frameworks
- Data protection and data security

Learning Outcomes

IT Service Management

On successful completion, students will be able to

- understand IT service management as the enabler of information technology strategies and operations objectives.
- define the touchpoints between IT service management and management information systems.
- differentiate between lightweight and heavyweight approaches to IT service management.
- understand benchmarks and assessments to measure the capability of a service provider and its IT service management competences.
- apply IT services management tools and platforms proactively based on current information technology research and advisory.

IT Governance and Compliance

On successful completion, students will be able to

- explain IT governance and compliance both as tools to achieve organizational goals and to satisfy regulatory requirements.
- know the different IT governance frameworks given, in particular the industry standard model COBIT.
- set out the processes and policies for administering and managing IT systems for ensuring compliance with local and international regulatory requirements.
- understand that ensuring compliance with the IT governance framework can be a daunting task that requires constant collection, organization, monitoring, analysis and reporting on event logs to detect and manage control-related activity.
- recognize the IT governance and compliance monitoring tools for ensuring that controls for information systems are effectively implemented, monitored, and maintained.

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 Computer Science & Software Development.	All Master Programmes in the IT & Technology field.

IT Service Management

Course Code: DLMBITGSM01

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

Course Description

This course focuses on the nature and practice of IT services that keep IT systems running. It introduces students to the knowledge and experience needed to provide IT as a service to organizations, mainly based on the IT Infrastructure Library (ITIL) which is the industry standard for this purpose.

Course Outcomes

On successful completion, students will be able to

- understand IT service management as the enabler of information technology strategies and operations objectives.
- define the touchpoints between IT service management and management information systems.
- differentiate between lightweight and heavyweight approaches to IT service management.
- understand benchmarks and assessments to measure the capability of a service provider and its IT service management competences.
- apply IT services management tools and platforms proactively based on current information technology research and advisory.

Contents

1. Introduction to IT Service Management
   - 1.1 IT Services, Business IT Services
   - 1.2 Service Level Agreement (SLA)
   - 1.3 IT Service Management
   - 1.4 Reference Models for IT Service Management
2. IT Infrastructure Library (ITIL)
   - 2.1 Purpose and content of the IT Infrastructure Library
   - 2.2 Service Live Cycle in ITIL
   - 2.3 Overview on Service Strategy and Operational Processes
   - 2.4 Continual Service Improvement
3. ITIL – Service Strategy

3.1 Business Relationship Management
3.2 Service Portfolio Management
3.3 Financial Management for Services
3.4 Demand Management

4. ITIL – Operational Processes: Service Design
4.1 Service Level Management
4.2 Service Catalogue Management
4.3 Availability Management
4.4 Service Continuity Management

5. ITIL – Operational Processes: Service Transition
5.1 Transition Planning and Support
5.2 Change Management
5.3 Service Asset and Configuration Management
5.4 Release and Deployment Management

6. ITIL – Operational Processes: Service Operation
6.1 Incident Management
6.2 Problem Management
6.3 Request Fulfilment
6.4 Event Management

Literature

Compulsory Reading

Further Reading

- Love, V. D. & Ness, L. R. (2016). Integrating ITSM into the Corporate Environment. Journal of Health Care Compliance, 18(3), 5—12.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

IT Governance and Compliance

Course Code: DLMBITGSM02

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

Course Description

IT governance and compliance are key elements within corporate governance, since most modern businesses rely heavily on IT infrastructure for their success. These elements detail the required leadership and organizational structures for maintaining and extending information technology in order to meet business strategies and objectives.

Course Outcomes

On successful completion, students will be able to

- explain IT governance and compliance both as tools to achieve organizational goals and to satisfy regulatory requirements.
- know the different IT governance frameworks given, in particular the industry standard model COBIT.
- set out the processes and policies for administering and managing IT systems for ensuring compliance with local and international regulatory requirements.
- understand that ensuring compliance with the IT governance framework can be a daunting task that requires constant collection, organization, monitoring, analysis and reporting on event logs to detect and manage control-related activity.
- recognize the IT governance and compliance monitoring tools for ensuring that controls for information systems are effectively implemented, monitored, and maintained.

Contents

1. About IT Governance
   - 1.1 Concept and Definitions
   - 1.2 The Value of IT in the Organization
   - 1.3 Current State and Perceptions
   - 1.4 Governance, Compliance and Risk Management in IT
2. Establishing IT Governance and Compliance
   - 2.1 Assessment
   - 2.2 IT Strategy
   - 2.3 Tactics
   - 2.4 Operations

2.5 Compliance
2.6 Performance

3. The COBIT Framework
   3.1 Overview of COBIT
   3.2 The COBIT Goals Cascade
   3.3 The COBIT Process Reference Model
   3.4 Deploying and Implementing COBIT

4. IT Governance Frameworks
   4.1 Quality Management as a Foundation
   4.2 ISO 9000 Family
   4.3 Maturity Models
   4.4 Relationship to Service and Architecture Frameworks (ITIL, TOGAF)
   4.5 Relationship to IT Security Frameworks (ISO 27000 family)

5. Data Protection and IT Security
   5.1 Data Protection
   5.2 IT Security Management
   5.3 IT Security Threats and Attack Scenarios
   5.4 Countermeasures
   5.5 Cryptography

Literature
Compulsory Reading
Further Reading ▪ Calder, A., & Watkins, S. G. (2020). IT governance [electronic resource]: an international guide to data security and ISO 27001/ISO 27002 (Seventh Edition). KoganPage.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

Instructional Methods

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

UI/UX Expert

Module Code: DLMAIEUIUX

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		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	Theory Course

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

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

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Practice Exam
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Online Tests
☑ Recorded Live Sessions	☑ Audio	
	☑ 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. ▪ Cooper, A., Reimann, R., Cronin, D., & Noessel, C. (2014). About face: The essentials of interaction design. Wiley. ▪ Johnson, J. (2010). Designing with the mind in mind. Elsevier. ▪ Microsoft Windows Dev Center. (2018). Guidelines. Retrieved from https://docs.microsoft.com/en-us/windows/desktop/uxguide/guidelines ▪ Preece, J., Sharp, H., & Rogers, Y. (2015). Interaction design: Beyond human-computer interaction. Wiley. ▪ Unger, R., & Chandler, C. (2012). A project guide to UX design. New Riders.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Data Engineer

Module Code: DLMDSEDE

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		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

Georgi Dimchev (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	Theory Course

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

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

Instructional Methods

Tutorial Support
- ☑ Course Feed
- ☑ Intensive Live Sessions/Learning Sprint
- ☑ Recorded Live Sessions

Learning Material
- ☑ Course Book
- ☑ Video
- ☑ Slides

Exam Preparation
- ☑ Online Tests
- ☑ Guideline

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 ▪ Farcic, V. (2016). The DevOps 2.0 toolkit: Automating the continuous deployment pipeline with containerized microservices. CreateSpace Independent Publishing Platform. ▪ Karau, H., Konwinski, A., Wendell, P., & Zaharia, M. (2015). Learning Spark: Lightning fast data analysis. O'Reilly Media. ▪ Kleppmann, M. (2017). Designing data intensive applications: The big ideas behind reliable, scalable, and maintainable systems. O'Reilly Media. ▪ Narkhede, N., Shapira, G., & Palino, T. (2017). Kafka: The definitive guide: Real-time data and stream processing at scale. O'Reilly Media. ▪ White, T. (2015). Hadoop: The definitive guide: Storage and analysis at Internet scale (4th ed.). O'Reilly Media.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Project

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

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

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

Business Analyst

Module Code: DLMDSEBA

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		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. Silke Vaas (Business Intelligence I) / Prof. Dr. Silke Vaas (Project: Business Intelligence)

Contributing Courses to Module

- Business Intelligence I (DLMDSEBA01)
- Project: Business Intelligence (DLMDSEBA02)

Module Exam Type

Module Exam	Split Exam
	Business Intelligence I • Study Format "Distance Learning": Written Assessment: Case Study Project: Business Intelligence • Study Format "Distance Learning": Portfolio

Weight of Module

see curriculum

Module Contents

Business Intelligence I

- Data acquisition and dissemination
- Data warehouse and multidimensional modeling
- Analytical systems
- Future Business Intelligence Application Areas

Project: Business Intelligence

Implementation of a business intelligence use case.

Learning Outcomes

Business Intelligence I

On successful completion, students will be able to

- understand the motivations and use cases for, as well as fundamentals of, business intelligence.
- explain relevant types of data.
- know and disambiguate techniques and methods for modeling and dissemination of data.
- expound upon the techniques and methods for the generation and storage of information.
- select apposite business intelligence methods for given requirements.
- explain current and future business intelligence application areas.

Project: Business Intelligence

On successful completion, students will be able to

- transfer knowledge of business intelligence methodology to real-world use cases.
- analyze the suitability of different approaches with respect to the project task.
- critically reason about relevant design choices.
- make apposite architectural choices.
- formulate and implement a business intelligence use case.

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 Programs in the IT & Technology field

Business Intelligence I

Course Code: DLMDSEBA01

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

Course Description

Business Intelligence is about the generation of information based on operational data. It is used to enable goal-oriented management practices as well as the optimization of relevant business activities. This course introduces and discusses techniques, methods, and models for data provisioning and the generation, analysis, and dissemination of information.

Course Outcomes

On successful completion, students will be able to

- understand the motivations and use cases for, as well as fundamentals of, business intelligence.
- explain relevant types of data.
- know and disambiguate techniques and methods for modeling and dissemination of data.
- expound upon the techniques and methods for the generation and storage of information.
- select apposite business intelligence methods for given requirements.
- explain current and future business intelligence application areas.

Contents

1. Motivation and Introduction
   - 1.1 Motivation and Historical Development of the Field
   - 1.2 Business Intelligence as a Framework
2. Data Provisioning
   - 2.1 Operative and Dispositive Systems
   - 2.2 The Data Warehouse Concept
   - 2.3 Architecture Variants
3. Data Warehouse
   - 3.1 The ETL-Process
   - 3.2 DWH and Data-Mart Concepts
   - 3.3 ODS and Meta-Data
4. Modeling Multidimensional Dataspaces

4.1 Data Modeling
4.2 OLAP-Cubes
4.3 Physical Storage Concepts
4.4 Star-Schema and Snowflake-Schema
4.5 Historization

5. Analytical Systems
   5.1 Freeform Data Analysis and OLAP
   5.2 Reporting Systems
   5.3 Model-Based Analytical Systems
   5.4 Concept-Oriented Systems

6. Distribution and Access
   6.1 Information Distribution
   6.2 Information Access

7. Current and Future Business Intelligence Application Areas
   7.1 Mobile Business Intelligence
   7.2 Predictive and Prescriptive Analytics
   7.3 Artificial Intelligence
   7.4 Agile Business Intelligence

Literature

Compulsory Reading

Further Reading

- Grossmann, W., Rinderle-Ma, S. (2015). Fundamentals of Business Intelligence. Berlin/ Heidelberg: Springer.
- Kolb, J. (2013). Business intelligence in plain language: A practical guide to data mining and business analytics. Createspace.
- Sharda, R., Delen, D., & Turban, E. (2014). Business intelligence and analytics: Systems for decision support. Pearson.
- Sharda, R., Delen, D., & Turban, E. (2017). Business intelligence, analytics, and data science: A managerial perspective. Pearson.
- Sherman, R. (2014). Business intelligence guidebook: From data integration to analytics. Morgan Kaufmann.
- Turban, E., Sharda, R., Aronson, J., & King, D. (2010). Business intelligence. A managerial approach (2nd ed.). Prentice Hall.
- Vaisman, A., & Zimányi, E. (2016). Data warehouse systems: Design and implementation. Springer.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Theory Course

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

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

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

Project: Business Intelligence

Course Code: DLMDSEBA02

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSEBA01

Course Description

In this course the students will transfer knowledge of business intelligence approaches and methods to the implementation of a real-world business analytical use case. To accomplish this goal, students must look closely at the given task and find an apposite approach by analyzing, evaluating, and comparing different solution strategies and their constituent parts. The found solution then has to be implemented in order to arrive at a running business analytical system.

Course Outcomes

On successful completion, students will be able to

- transfer knowledge of business intelligence methodology to real-world use cases.
- analyze the suitability of different approaches with respect to the project task.
- critically reason about relevant design choices.
- make apposite architectural choices.
- formulate and implement a business intelligence use case.

Contents

- This second course in the Business Analyst specialization aims at the practical implementation of a business intelligence project. Students can choose from a list of project topics or contribute their own ideas.

Literature

Compulsory Reading

Further Reading

- Kimball, R. (2013). The data warehouse toolkit: The definitive guide to dimensional modeling (3rd ed.). Indianapolis, IN: Wiley.
- Linstedt, D., & Olschimke, M. (2015). Building a scalable data warehouse with Data Vault 2.0. Waltham, MA: Morgan Kaufmann.
- Provost, F. (2013). Data science for business: What you need to know about data mining and data-analytic thinking. Sebastopol, CA: O'Reilly.
- Sherman, R. (2014). Business intelligence guidebook: From data integration to analytics. Waltham, MA: Morgan Kaufmann.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Machine Learning and Deep Learning

Module Code: DLMCSEMLDL

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		MA	10	150 h

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

Module Coordinator

Prof. Dr. Visieu Lac (Machine Learning) / Prof. Dr. Visieu Lac (Deep Learning)

Contributing Courses to Module

- Machine Learning (DLMDSML01)
- Deep Learning (DLMDSDL01)

Module Exam Type

Module Exam	Split Exam
	Machine Learning • Study Format "Distance Learning": Exam, 90 Minutes Deep Learning • Study Format "Distance Learning": Oral Assignment

Weight of Module

see curriculum

Module Contents

Machine Learning

- 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

Deep Learning

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

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.

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

Machine Learning

Course Code: DLMDSML01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	CSEMDSAM01-01, CSEMDSPWP01

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.
- Hands-On machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems (Third edition). (2022). O'Reilly.
- 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.
- Ng, A. (2021). Machine learning yearning. Self-published. https://info.deeplearning.ai/machine-learning-yearning-book
- Raschka, S., & Mirjalili, V. (2019). Python machine learning: Machine learning and deep learning with Python, scikit-learn, and TensorFlow 2 (3rd ed.). Packt Publishing Ltd.
- 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 Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Deep Learning

Course Code: DLMDSDL01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	CSEMDSAM01-01, CSEMDSPWP01, DLMDSML01

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

Literature

Compulsory Reading

Further Reading

- Chollet, F. (2021). Deep learning with Python (2nd ed.). Manning Publications.
- Geron, A. (2022). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow (3rd ed.). O'Reilly Media Inc.
- Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT Press.
- Russel, S., & Norvig, P. (2022). Artificial intelligence – A modern approach (4th ed.). Pearson.
- Shrestha, A., & Mahmood, A. (2019). Review of deep learning algorithms and architectures. IEEE Access, 7, 53040-53065.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

Instructional Methods

Tutorial Support
- ☑ Course Feed
- ☑ Intensive Live Sessions/Learning Sprint
- ☑ Recorded Live Sessions

Learning Material
- ☑ Course Book
- ☑ Slides

Exam Preparation
- ☑ Online Tests
- ☑ Guideline

Use Case Identification and Evaluation for Analytical Applications

Module Code: DLMCSEUCIAA

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		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. Claudia Heß (Use Case and Evaluation) / Prof. Dr. Gissel Velarde Perez (Project: Data Science Use Case)

Contributing Courses to Module

- Use Case and Evaluation (DLMDSUCE01)
- Project: Data Science Use Case (DLMDSPDSUC01)

Module Exam Type

Module Exam	Split Exam
	Use Case and Evaluation • Study Format "Distance Learning": Oral Assignment Project: Data Science Use Case • Study Format "Distance Learning": Portfolio

Weight of Module

see curriculum

Module Contents

Use Case and Evaluation

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

Project: Data Science Use Case

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.

Project: Data Science Use Case

On successful completion, students will be able to

- apply the concepts covered in the preceding data science courses to build a running analytical model or system.
- explain the design choices made in the selection of the employed model and its implementation.
- transfer acquired theoretical knowledge to real case studies.
- translate the learned theories into the practice of data science system building.
- critically evaluate the resulting model 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 field of Data Science & Artificial Intelligence.	All Master Programmes 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.). Analytics Press.
- Gilliland, M., Tashman, L., & Sglavo, U. (2016). Business forecasting: Practical problems and solutions. John Wiley & Sons.
- Hyndman, R. (2018). Forecasting: Principles and practice (2nd ed.). OTexts.
- Kahneman, D. (2012). Thinking, fast and slow. Penguin Books.
- Osterwalder, A., & Pigneur, Y. (2010). Business model generation. Wiley.
- Parmenter, D. (2015). Key performance indicators: Developing, implementing, and using winning KPIs. John Wiley & Sons.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

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

Project: Data Science Use Case

Course Code: DLMDSPDSUC01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSUCE01

Course Description

In this course, students choose a project task in accord with their tutor from a variety of options. The goal is to prototypically implement a data science 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 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 data science courses to build a running analytical model or system.
- explain the design choices made in the selection of the employed model and its implementation.
- transfer acquired theoretical knowledge to real case studies.
- translate the learned theories into the practice of data science system building.
- critically evaluate the resulting model or system's performance

Contents

- In this project course the students work on a practical implementation of a data science 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

- 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.). OTexts.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	Project

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

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

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

Technical Project Lead

Module Code: DLMDSETPL

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum		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 Charts
   - 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. Wrox, a Wiley Brand.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Theory Course

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

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

Instructional Methods		
Tutorial Support	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Practice Exam
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Online Tests
☑ Recorded Live Sessions	☑ 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. John Wiley & Sons.
- Kneuper, R. (2018). Software processes and lifecycle models. Springer Nature Switzerland.
- Phillips, J. (2010). IT project management: On track from start to finish (3rd ed.). 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. Microsoft Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Internship

Module Code: FSINTER

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	None		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. Andreas Simon (Internship)

Contributing Courses to Module

- Internship (FSINTER01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Internship Reflection Paper (passed / not passed)	

Weight of Module

see curriculum

Module Contents

Internship according to the Internship Regulations of the IU.

Learning Outcomes

Internship

On successful completion, students will be able to

- apply skills and knowledge they have obtained previously during their study program in an entrepreneurial environment.
- develop his / her practical and analytical skills in order to improve his / her employability.
- have practical knowledge and learn to work within an organization.
- acquire a first deep insight into organizational structures and communication procedures.
- apply comminication skills, socials skills, problem solving, time and project management which will shape their general management skills.
- shape their personality with the help of the interdisciplinary nature of the course especially in the area of the key qualifications like interpersonal skills or intercultural skills.

Links to other Modules within the Study Program	**Links to other Study Programs of the University**
Builds on modules of the chosen degree program	All myStudies programs

Internship

Course Code: FSINTER01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
	English		10	None

Course Description

This module consists of two parts: (1) preparation tutorials and (2) the internship itself. During the preparation tutorials, students will learn about the intention of the internship and about the intellectual as well as social requirements of the working environment.

Course Outcomes

On successful completion, students will be able to

- apply skills and knowledge they have obtained previously during their study program in an entrepreneurial environment.
- develop his / her practical and analytical skills in order to improve his / her employability.
- have practical knowledge and learn to work within an organization.
- acquire a first deep insight into organizational structures and communication procedures.
- apply comminication skills, socials skills, problem solving, time and project management which will shape their general management skills.
- shape their personality with the help of the interdisciplinary nature of the course especially in the area of the key qualifications like interpersonal skills or intercultural skills.

Contents

- Internship according to the Internship Regulations of the IU.

Literature

Compulsory Reading

Further Reading

- Sweitzer, F. H. & King, M. A. (2009). The Successful Internship: Personal, Professional, and Civic Development. 3rd ed.. Cengage. ISBN: 0-495-59642-6.
- Kaser, K., Brooks, J. R. & Brooks, K. (2007). Making the Most of your Internship. Thomson. ISBN: 0-538-44432-0.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Internship Reflection Paper (passed / not passed)

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
0 h	0 h	0 h	0 h	300 h	300 h

Instructional Methods
Tutorial Support ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions

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": Master Thesis (90) Colloquium • Study Format "Distance Learning": 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 of Methods	All Master Programmes in the Business field

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 Course

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

Student Workload					
Self Study	**Contact Hours**	**Tutorial/Tutorial Support**	**Self Test**	**Independent Study**	**Hours Total**
810 h	0 h	0 h	0 h	0 h	810 h

Instructional Methods

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 ed.). Springer Gabler.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Thesis Course

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

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

Instructional Methods