MODULE HANDBOOK

Master of Science

Master Data Management (FS-OI-MADM-120)

120 ECTS Credits

Distance Learning

As of October 29th, 2026

INTERNATIONAL
UNIVERSITY OF
APPLIED SCIENCES

Classification: Consecutive

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1. Semester

Concepts in Data Management

Module Code: DLMDMCDM

Module Type	Admission Requirements	Study Level	ECTS Credits	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 (Concepts in Data Management)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Concepts in Data Management (DLMDMCDM01)

Module Exam Type

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

Module Contents

Concepts in Data Management

- The Data Processing Lifecycle
- Data Protection and Security
- Distributed Data
- Data Quality and Data Governance
- Data Modeling
- Metadata Management

Learning Outcomes

Concepts in Data Management

On successful completion, students will be able to

- explain the steps of the data processing lifecycle and organize and adapt suitable techniques for each of these steps.
- evaluate suitable data protection and security measures for data-intensive systems to comply with ethics in data handling considering varying cultural perspectives on this topic.
- consider interdisciplinary requirements towards data-intensive systems as expressed by the end-users of these systems.
- describe the advantages and apply techniques for distributing data over multiple machines.
- assess and apply suitable techniques which comply with principles of data governance and data quality.
- explain and apply common data modeling techniques.
- describe different types of metadata, explain the meaning and importance of metadata and organize metadata for data-intensive systems.

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 Intellgence	All Master Programs in theIT & Technology field

Concepts in Data Management

Course Code: DLMDMCDM01

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

Course Description

In data-intensive systems, there are concepts and principles which are universal for almost all projects. Data management usually spans over all stages of the data processing lifecycle including working in an interdisciplinary way to meet the diverse requirements of the end-users. In this course, students learn the meaning of each step of the data processing lifecycle and are enabled to use suitable techniques for each of these steps. In data ingestion and integration, students learn principles and techniques which enable them to ingest and integrate heterogeneous data from various data sources. As the core of most data management projects, students will learn data processing and storage techniques. To build data-intensive systems in an effective and goal-oriented way, students are presented with principles and techniques for data analysis and reporting. As storing and processing data becomes more prevalent in organizations as well as in everyday life, students learn about ethics in data handling in varying cultural contexts and about complying with legal regulations and corresponding techniques. As far as scalability and reliability is concerned, students learn how distributing data across multiple machines can increase the performance of the system and the resilience and ease of recovery from failovers. With respect to organizing data for interdisciplinary usages in organizations and businesses, students learn principles and techniques for data governance, data modeling and data quality. Finally, students are enabled to understand different types of metadata and their respective meaning and organization in data management projects.

Course Outcomes

On successful completion, students will be able to

- explain the steps of the data processing lifecycle and organize and adapt suitable techniques for each of these steps.
- evaluate suitable data protection and security measures for data-intensive systems to comply with ethics in data handling considering varying cultural perspectives on this topic.
- consider interdisciplinary requirements towards data-intensive systems as expressed by the end-users of these systems.
- describe the advantages and apply techniques for distributing data over multiple machines.
- assess and apply suitable techniques which comply with principles of data governance and data quality.
- explain and apply common data modeling techniques.
- describe different types of metadata, explain the meaning and importance of metadata and organize metadata for data-intensive systems.

Contents

1. The Data Processing Lifecycle
   - 1.1 Data Ingestion and Integration
   - 1.2 Data Processing
   - 1.3 Data Storage
   - 1.4 Data Analysis
   - 1.5 Reporting

2. Data Protection and Security
   - 2.1 Ethics in Data Handling
   - 2.2 Data Protection Principles
   - 2.3 Data Encryption
   - 2.4 Data Masking Strategies
   - 2.5 Data Security Principles & Risk Management

3. Distributed Data
   - 3.1 Systems' Reliability and Data Replication
   - 3.2 Data Partitioning
   - 3.3 Processing Frameworks for Distributed Data

4. Data Quality and Data Governance
   - 4.1 Data and Process Integration
   - 4.2 Data as a Service
   - 4.3 Data Virtualization
   - 4.4 Data Governance

5. Data Modeling
   - 5.1 Entity Relationship Model
   - 5.2 Data Normalization
   - 5.3 Star and Snowflake Schema

6. Metadata Management
   - 6.1 Types of Metadata
   - 6.2 Metadata Repositories

Literature
Compulsory Reading

Further Reading

- Kleppmann, M. (2017): Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. 1st Edition, O'Reilly, Sebastopol, CA.
- Plotkin, D. (2020): Data Stewardship: An Actionable Guide to Effective Data Management and Data Governance. 2nd Edition, Academic Press, Cambridge, MS
- Strengholt, P. (2020): Data Management at Scale: Best Practices for Enterprise Architecture. 1st Edition, O'Reilly, Sebastopol, CA
- Van Gils, B. (2020): Data Management: a gentle introduction. 1st Edition, Van Haren Publishing, 's-Hertogenbosch, NL
- Sebastian-Coleman, L. (2018): Navigating the Labyrinth: An Executive Guide to Data Management. 1st Edition, Technics Publications, Basking Ridge, NJ.
- Steenbeek, I. (2019): The Data Management Toolkit: A step-by-step implementation guide for the pioneers of data management. 1st Edition, Independently Published, n. p.
- Strengholt, P. (2020): Data Management at Scale: Best Practices for Enterprise Architecture. 1st Edition, O'Reilly, Sebastopol, CA.
- Van Gils, B. (2020): Data Management: a gentle introduction. 1st Edition, Van Haren Publishing, 's-Hertogenbosch, NL.

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

Learning Material
- ☑ Course Book
- ☑ Video
- ☑ Audio

Exam Preparation
- ☑ Practice Exam
- ☑ Online Tests

Database Concepts and Technologies

Module Code: DLMDMDCT

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

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

Module Coordinator
Prof. Dr. Neil Arvin Bretana (Database Concepts and Technologies)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Database Concepts and Technologies (DLMDMDCT01)

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

Module Contents

Database Concepts and Technologies

- Databases Overview
- Database Technologies
- Distributed Databases
- Database Access Control and Security
- Selected Databases in Practice

Learning Outcomes

Database Concepts and Technologies

On successful completion, students will be able to

- differentiate types of databases, evaluate their respective usages, and describe their major components.
- explain and apply common database principles and technologies, such as the ACID principle and indexing strategies.
- explain and apply techniques for distributed databases, such as fragmentation, sharding and the assessment of consistency levels.
- describe and implement techniques for database access control, data protection and database security. in varying cultural contexts and perspectives on this topic.
- differentiate between common databases and conduct basic database handling tasks in these databases.

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 & Articial Intelligence	All Master Programs in the IT & Technology field

Database Concepts and Technologies

Course Code: DLMDMDCT01

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

Course Description

Storing and managing data in databases is at the very heart of data management. In this course, students learn about concepts and technologies for the management and usage of databases. Students are provided with an in-depth look into the concepts and inner workings of databases and their major components. Students learn to differentiate between different categories of databases, and are enabled to understand and use database principles and technologies such as the ACID principle, the differentiation between OLAP and OLTP systems, indexing strategies and industry standards for connecting to databases. As modern systems tend to increase in data volume, students learn how distributing databases across clusters of machines can increase the scalability and reliability of data systems. Students learn concepts and techniques for distributing data across clusters, such as fragmentation and sharding, as well as the challenges and strategic decisions to be made within this context, such as the compliance with consistency levels. With focus on databases, students learn about data protection and security, ethics and principles, as well as practical techniques to facilitate the compliance with these principles under varying cultural contexts and perspectives. Finally, students are enabled to differentiate between common databases and learn how to practically perform common database tasks in each respective database.

Course Outcomes

On successful completion, students will be able to

- differentiate types of databases, evaluate their respective usages, and describe their major components.
- explain and apply common database principles and technologies, such as the ACID principle and indexing strategies.
- explain and apply techniques for distributed databases, such as fragmentation, sharding and the assessment of consistency levels.
- describe and implement techniques for database access control, data protection and database security. in varying cultural contexts and perspectives on this topic.
- differentiate between common databases and conduct basic database handling tasks in these databases.

Contents

1. Databases Overview
   - 1.1 File-based and Database Storage

1.2 The DAMA-DMBOK Framework
1.3 Database Components
1.4 Database Categorization

2. Database Technologies
2.1 The ACID Principle for Databases
2.2 OLAP and OLTP
2.3 Indexing
2.4 Connecting to Databases

3. Distributed Databases
3.1 Database Clusters
3.2 Vertical Fragmentation and Sharding
3.3 Consistency and Availability

4. Database Access Control and Security
4.1 Data Handling Ethics
4.2 Encryption Methods
4.3 Database Access Control
4.4 Database Security

5. Selected Databases in Practice
5.1 MySQL
5.2 PostgreSQL
5.3 SQL Server
5.4 Snowflake

Literature

Compulsory Reading

Further Reading

- Beaulieu, A. (2020): Learning SQL. 3rd Edition, O'Reilly, Sebastopol, CA.
- DAMA International (2017): DAMA-DMBOK: Data Management Body of Knowledge. 2nd Edtion, Technics Publications, Basking Ridge, NJ.
- Kleppmann, M. (2017): Designing data-intensive applications. The big ideas behind reliable, scalable, and maintainable systems. 1st Edition. O'Reilly, Sebastopol, CA.
- Lemahieu, W. (2018): Principles of Database Management: The Practical Guide to Storing, Managing and Analyzing Big and Small Data. 1st Edition, Cambridge University Press, Cambridge, UK.

- Petrov, A. (2019): Database Internals: A deep-dive into how distributed data systems work. 1st Edition, O'Reilly, Sebastapol, CA.

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
	☑ Audio	

Data Query Languages

Module Code: DLMDMDQL

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Thomas Kopsch (Data Query Languages)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Data Query Languages (DLMDMDQL01)

Module Exam Type	
Module Exam Study Format: Distance Learning Oral Assignment	**Split Exam**

Module Contents

Data Query Languages

- Definition of Data Query Languages and Typical Examples
- Different Types of Data and the Role of Databases
- Data Query Languages and Standards
- Fundamentals of SQL
- Use of Data Query Languages for NoSQL Database and other Purposes
- Data Query Languages in the Context of Application Programming

Learning Outcomes

Data Query Languages

On successful completion, students will be able to

- understand the basics of data query languages.
- understand different data structuring options and types of data sources.
- explain the difference between various data query languages, their application and their distinction from other programming languages.
- review and determine data query languages for appropriate use.
- apply and create SQL queries on self-created and given data in relational databases.
- understand the use of data query languages for application programming.

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

Data Query Languages

Course Code: DLMDMDQL01

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

Course Description

The course is a general introduction to data query languages and the use by application interface-oriented and programming-oriented approaches, with a focus on SQL for relational databases.

Course Outcomes

On successful completion, students will be able to

- understand the basics of data query languages.
- understand different data structuring options and types of data sources.
- explain the difference between various data query languages, their application and their distinction from other programming languages.
- review and determine data query languages for appropriate use.
- apply and create SQL queries on self-created and given data in relational databases.
- understand the use of data query languages for application programming.

Contents

1. Introduction to Data Query Languages
   - 1.1 Definition of Data Query Languages
   - 1.2 Differentiation to other Languages
   - 1.3 Typical Examples of Data Query Languages
2. Data Management
   - 2.1 Data Life Cycle
   - 2.2 Types of Datasets (Structured, Semi-Structured and Unstructured Data)
   - 2.3 Role of Databases (SQL & NoSQL Databases)
3. Fundamentals of SQL
   - 3.1 Brief Overview
   - 3.2 Data Definition Language (DDL)
   - 3.3 Data Query Language (DQL)
   - 3.4 Data Manipulation Language (DML)
4. Advanced SQL

4.1 Transaction Control Language (TCL)
4.2 Data Control Language (DCL)
4.3 Differences between various SQL Versions (MSSQL, PL/SQL, etc.)

5. Data Query Languages for NoSQL Database and other Purposes
5.1 Document Databases (N1QL/couchbase and MongoDB)
5.2 Graph Databases (Cypher/Neo4j)
5.3 GraphQL for APIs

6. Using Data Query Languages within Application Programming
6.1 Special Aspects (Architecture, Connection Management, Coding and Testing)
6.2 Examples (SQL in Python and SQL in Java)

Literature

Compulsory Reading

Further Reading

- Meier, A., & Kaufmann, M. (2019). SQL & NoSQL databases: Models, languages, consistency options and architectures for big data management (pp. 1–83). Springer Vieweg.
- Beaulieu, A. (2020). Learning SQL: Generate, manipulate, and retrieve data (3rd ed.). O'Reilly.
- Perkins, L., Wilson, J. R., & Redmond, E. (2018). Seven databases in seven weeks: A guide to modern databases and the NoSQL movement (2nd ed.). Pragmatic Bookshelf.

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	

NoSQL Databases

Module Code: DLMDMNDB

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Thomas Kopsch (NoSQL Databases)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- NoSQL Databases (DLMDMNDB01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Oral Assignment	

Module Contents

NoSQL Databases

- SQL Databases
- NoSQL Concepts
- Key-Value-oriented Databases
- Document-oriented Databases
- Column-oriented Databases
- Graph-oriented Databases

Learning Outcomes

NoSQL Databases

On successful completion, students will be able to

- differentiate between Relational Databases and NoSQL Databases in terms of usage and underlying principles.
- explain universal concepts of NoSQL Databases, such as no strongly enforced schema.
- clarify the different concepts of Key-Value-oriented Databases, Document-oriented, Column-oriented and Graph-oriented Databases, use common databases of these kinds in data-intensive projects and assess their suitabilities for specific use cases.

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

NoSQL Databases

Course Code: DLMDMNDB01

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

Course Description

The usefulness of relational SQL databases has been proven by their universal distribution and diverse applications. In some aspects, however, relational SQL databases do not meet the requirements of modern applications in terms of, for instance, flexibility and cardinality. This gave birth to a family of database concepts which became known as NoSQL databases. In this course, students learn how traditional SQL databases are different from these NoSQL databases which usually, and as one of the most noticeable characteristics, do not enforce a data schema on write. Students acquire a thorough understanding of the concepts of NoSQL databases and learn how to evaluate the suitability of various NoSQL databases for specific data-intensive projects. Students are enabled to explain the main concepts of Key-Value-oriented, Document-oriented, Column-oriented and Graph-oriented Databases and will be provided with applied examples for each of these database types. Finally, students learn how to practically use these databases in specific problem-oriented use cases.

Course Outcomes

On successful completion, students will be able to

- differentiate between Relational Databases and NoSQL Databases in terms of usage and underlying principles.
- explain universal concepts of NoSQL Databases, such as no strongly enforced schema.
- clarify the different concepts of Key-Value-oriented Databases, Document-oriented, Column-oriented and Graph-oriented Databases, use common databases of these kinds in data-intensive projects and assess their suitabilities for specific use cases.

Contents

1. SQL Databases
   - 1.1 Principles of Relational Databases
   - 1.2 Overview over common Relational Databases
   - 1.3 Introduction to SQL
   - 1.4 Cardinality and its Limits
   - 1.5 The Relational and Document Model
2. NoSQL Concepts
   - 2.1 Schemaless Data and the ACID Principle

2.2 Consistency and Availability
2.3 Row-based and Column-based Storage
2.4 Updates and Appends
2.5 Multi-model Databases

3. Key-Value-oriented Databases
   3.1 The Concept of Key-Value-oriented Databases
   3.2 Redis
   3.3 DynamoDB
   3.4 Ignite

4. Document-oriented Databases
   4.1 The Concept of Document-oriented Databases
   4.2 MongoDB
   4.3 CouchDB
   4.4 OrientDB

5. Column-oriented Databases
   5.1 The Concept of Column-oriented Databases
   5.2 Cassandra
   5.3 HBase
   5.4 CosmosDB

6. Graph-oriented Databases
   6.1 The Concept of Graph-oriented Databases
   6.2 Neo4j

Literature

Compulsory Reading

Further Reading

- Bradshaw, S./Brazil, E./Chodorow, K. (2019): MongoDB: The Definite Guide. 3rd Edition, O'Reilly, Sebastopol, CA.
- Carpenter, J./Hewitt, E. (2020): Cassandra: The Definite Guide. 3rd Edition, O'Reilly, Sebastopol, CA.
- George, L. (2011): HBase: The Definitive Guide. 1st Edition, O'Reilly, Sebastopol, CA.
- Harrison, G. (2016): Next Generation Databases: NoSQL, NewSQL, and Big Data. 1st Edition, Apress, New York, NY.

- Hillar, G. C./Yondem, D. (2018): Guide to NoSQL with Azure Cosmos DB: Work with the massively scalable Azure database service with JSON, C#, LINQ, and .NET Core 2. 1st Edition, Packt Publishing, Birmingham, UK.
- Hodler, A. (2019): Graph Algorithms: Practical Examples in Apache Spark and Neo4j. 1st Edition, O'Reilly, Sebastopol, CA.
- Holt, B. (2011): Scaling CouchDB. 1st Edition, O'Reilly, Sebastopol, CA.
- Kelly, A./McCreary, D. (2013): Making Sense of NoSQL. 1st Edition, O'Reilly, Sebastopol, CA.
- Nelson, J. (2016): Mastering Redis. 1st Edition, Packt Publishing, Birmingham, UK.
- Ploetz, A./Kandhare, D./Kadambi, S./Wu, X. (2018): Seven NoSQL Databases in a Week. 1st Edition, Packt Publishing, Birmingham, UK.
- Sadalage, P. (2009): NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence. 1st Edition, Addison-Wesley Professional, Boston, MS.

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	

Seminar: Ethic & Societal Considerations in Data Management

Module Code: DLMDMSESC

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Marc Borner (Seminar: Ethic & Societal Considerations in Data Management)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Seminar: Ethic & Societal Considerations in Data Management (DLMDMSESC01)

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

Module Contents

Seminar: Ethic & Societal Considerations in Data Management

At the end of the module “Ethic & Societal Considerations in Data Management” students are able to identify and explain the societal, political and economic effects and side-effects of data management. They also know about adequate solution approaches addressing those effects. During the course they write a scientific paper on a specialist topic proving their ability to independently analyze selected topics and link them with well-known concepts, as well as to critically question and discuss them.

Learning Outcomes

Seminar: Ethic & Societal Considerations in Data Management

On successful completion, students will be able to

- explain the influence and impact of 'Big Data' applications on societal, economic, and political topics.
- understand the general ethical relevance of data management techniques.
- explain the critical data study approach and its main drivers.
- name selected current societal topics and issues in data management in the fields of privacy, health, social media, personal finance etc.
- describe approaches and methods to solve the identified problems.
- treat a selected topic in a scientific manner in the form of a written essay.
- critically question and discuss current societal and political issues arising from the recent advances in data management.
- develop problem-solving skills and processes through reflection on the possible impact of their future occupation in the sector of data management.

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

Seminar: Ethic & Societal Considerations in Data Management

Course Code: DLMDMSESC01

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

Course Description

Over the last decade Big Data applications have become an underlying matter of course for many activities in private, professional, and social life. This course discusses impacts and side-effects of data management applications from an ethical and societal perspective and provides adequate solution approaches.

Course Outcomes

On successful completion, students will be able to

- explain the influence and impact of 'Big Data' applications on societal, economic, and political topics.
- understand the general ethical relevance of data management techniques.
- explain the critical data study approach and its main drivers.
- name selected current societal topics and issues in data management in the fields of privacy, health, social media, personal finance etc.
- describe approaches and methods to solve the identified problems.
- treat a selected topic in a scientific manner in the form of a written essay.
- critically question and discuss current societal and political issues arising from the recent advances in data management.
- develop problem-solving skills and processes through reflection on the possible impact of their future occupation in the sector of data management.

Contents

- The course covers current topics concerning the societal impact of data management.
- Problems like violation of privacy, surveillance capitalism, invasive marketing, misuse of health records and data, algorithmic discrimination concerning race, gender, religion or sexual attitude, political persecution or dissemination of fake news are among the topics the students have to analyze. Solution approaches like privacy concepts and compliance, legal regulations, codes of conduct or counter mapping should be identified and mapped to the specific problem field.

Literature

Compulsory Reading

Further Reading

- Boyd, D./Crawford, K. (2012): Critical Questions for Big Data. In: Information, Communication & Society, 15:5, p. 662-679.
- Clegg, B. (2017): Big data. How the information revolution is transforming our lives. London: Icon Books Ltd (Hot Science).
- Collman, J./Matei, S. A. (2018): Ethical Reasoning in Big Data: An Exploratory Analysis. Springer, Basel.
- Dalton, C./Thatcher, J. (2014): What does a critical data studies look like, and why do we care? (URL: https://www.societyandspace.org/articles/what-does-a-critical-data-studies-look-like-and-why-do-we-care, [Retrieved 28.02.2021])
- Davis, K. (2012): Ethics of Big Data: Balancing Risk and Innovation. O'Reilly, USA.
- Franks, B. (2020): 97 Things About Ethics Everyone in Data Science Should Know: Collective Wisdom from the Experts. O'Reilly, USA.
- Iliadis, A./Russo, F. (2016): Critical data studies: An introduction. In: Big Data & Society 3 (2), 205395171667423.
- Kitchen, R. (2014): The Data Revolution. SAGE Publications Ltd, USA.
- Loukides, M./Mason, H./Patil, DJ. (2018): Ethics and Data Science. O'Reilly, USA.
- O'Keefe, C./Brien D. O. (2018): Ethical Data and Information Management: Concepts, Tools and Methods. Kogan Page, London UK.
- Schäfer, M. T./van Es, K. (Hg.) (2017): The datafied society. Studying culture through data. Amsterdam: Amsterdam University Press.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

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

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

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

Advanced Research Methods

Module Code: DLMARM-01

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Markus Hemmer (Advanced Research Methods)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Advanced Research Methods (DLMARM01-01)

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

Module Contents

Advanced Research Methods

- Principles of Research
- Research Approaches
- The Research Project
- Selected Formal Techniques
- Selected Interpretative Topics
- Scientific Reporting

Learning Outcomes

Advanced Research Methods

On successful completion, students will be able to

- demonstrate an understanding of principles of scientific inquiry and logical reasoning.
- apply formal techniques to modeling and theory generation.
- apply interpretative techniques to intercultural case studies.
- propose, plan, and conduct research projects under ethical constraints.
- evaluate study results to arrive at valuable and ethical conclusions.
- report study results responsibly in an objective and comprehensible form.

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 Research Methods

Course Code: DLMARM01-01

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

Course Description

Advanced research methods, specifically business research, is scientific inquiry that attempts to uncover new information which helps a business improve performance, maximizing shareholder value while adhering to ethical and moral compliance standards.
Managers seeking to conduct empirical research must maintain validity, reliability, and trustworthiness when utilizing scientific methodologies in order to produce meaningful and actionable results. Research proposals are typically written prior to conducting research, which have a certain structure, enabling the researcher to properly plan, conduct, and analyze case studies and surveys. Different data collection strategies are used to collect both qualitative and quantitative data, depending on the research proposal goals. Managers utilize their understanding of research methodologies to accurately assess the quality of research.

Course Outcomes

On successful completion, students will be able to

- demonstrate an understanding of principles of scientific inquiry and logical reasoning.
- apply formal techniques to modeling and theory generation.
- apply interpretative techniques to intercultural case studies.
- propose, plan, and conduct research projects under ethical constraints.
- evaluate study results to arrive at valuable and ethical conclusions.
- report study results responsibly in an objective and comprehensible form.

Contents

1. Principles of Research
   - 1.1 Scientific Inquiry
   - 1.2 Principles of Reasoning
   - 1.3 From Data to Knowledge
   - 1.4 Models & Theories
   - 1.5 The Research Cycle

2. Research Approaches
   - 2.1 Experimental Design
   - 2.2 Engineering & Development
   - 2.3 Empirical Research & Case Studies

2.4 Interpretative Studies

3. The Research Project
   - 3.1 Topic Generation
   - 3.2 Types of Literature Reviews
   - 3.3 Developing a Research Design
   - 3.4 The Research Proposal

4. Selected Formal Techniques
   - 4.1 Foundations of Probability Theory & Inferential Statistics
   - 4.2 Data Acquisition
   - 4.3 Pattern Recognition & Classification
   - 4.4 Modelling & Theory Generation
   - 4.5 Artificial Intelligence in Research

5. Selected Interpretative Topics
   - 5.1 Phenomenology
   - 5.2 Hermeneutics & Discourse Analysis
   - 5.3 Ethnography & Ethnomethodology
   - 5.4 Critical Management Theory

6. Scientific Reporting
   - 6.1 Results Presentation & Visualization
   - 6.2 Interpretation
   - 6.3 Argumentation & Discussion
   - 6.4 Conclusions
   - 6.5 Ethical Considerations

Literature

Compulsory Reading

Further Reading

- Babbie, E. R. (2021). The practice of social research (15th ed.). Cengage Learning.
- Babbie, E. R. (2016). The practice of social research (14th ed.). Cengage Learning.
- Crossman, A. (2019). How to conduct an index for research. https://www.thoughtco.com/index-for-research-3026543
- Eurostat. (n.d.). Beginners: Statistical concept - Index and base year. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Beginners:Statistical_concept_-_Index_and_base_year

- Giles, D. (2004). Advanced research methods in psychology (Reprint). Psychology Press.
- Rea, L.M., & Parker, R.A. (2014). Designing and conducting survey research: A comprehensive guide, (4th ed). Jossey-Bass.
- Saunders, M., Thornhill, A., & Lewis, P. (2019). Research methods for business students (8th ed). Pearson.
- Takahashi, A. R. W., & Araujo, L. (2019). Case study research: Opening up research opportunities. RAUSP Management Journal, 55(1), 100–111.
- Widner, J., Woolcock, M., & Ortega Nieto, D. (Eds.). (2022). The case for case studies: Methods and applications in international development (strategies for social inquiry). Cambridge University 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	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
☑ Recorded Live Sessions		

Study Format myStudies

Study Format	**Course Type**
myStudies	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
☑ Recorded Live Sessions		

2. Semester

Data Engineering

Module Code: DLMDSEDE1

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Thomas Zöller (Data Engineering)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Data Engineering (DLMDSEDE01)

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

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

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.

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

Data Engineering

Course Code: DLMDSEDE01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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	**Learning Material**	**Exam Preparation**
☑ Course Feed	☑ Course Book	☑ Online Tests
☑ Intensive Live Sessions/Learning Sprint	☑ Video	☑ Guideline
☑ Recorded Live Sessions		

Study Format myStudies

Study Format	**Course Type**
myStudies	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		

Big Data Technologies

Module Code: DLMDSBDT

Module Type	Admission Requirements	Study Level	ECTS Credits	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)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Big Data Technologies (DLMDSBDT01)

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

Module Contents

Big Data Technologies

- Data Types and Data Sources
- Databases
- Modern data 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: DLMDSBDT01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 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		

Study Format myStudies

Study Format	**Course Type**
myStudies	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		

Data Warehousing, Pipelines and Orchestration

Module Code: DLMDMDWPO

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Andrew Adjah Sai (Data Warehousing, Pipelines and Orchestration)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Data Warehousing, Pipelines and Orchestration (DLMDMDWPO01)

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

Module Contents

Data Warehousing, Pipelines and Orchestration

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

Learning Outcomes

Data Warehousing, Pipelines and Orchestration

On successful completion, students will be able to

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

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

Data Warehousing, Pipelines and Orchestration

Course Code: DLMDMDWPO01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

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

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

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

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

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

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

Literature

Compulsory Reading

Further Reading

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

- Uttamchandani, S. (2020): The Self-Service Data Roadmap. Democratize Data and Reduce Time to Insight. O'Reilly, Sebastopol, CA.

Study Format Distance Learning

Study Format	**Course Type**
Distance Learning	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	
☑ Recorded Live Sessions		

Managing Data Projects

Module Code: DLMDMMDP

Module Type	Admission Requirements	Study Level	ECTS Credits	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

Aditya Mushyam (Managing Data Projects)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Managing Data Projects (DLMDMMDP01)

Module Exam Type

Module Exam	Split Exam
Study Format: Distance Learning Oral Assignment	

Module Contents

Managing Data Projects

- Agile Project Management for data-intensive projects
- Infrastructure as Code
- Continuous Integration/Continuous Delivery
- Testing and Collaboration
- Container Communication and Networking
- Tools for Managing Data Projects

Learning Outcomes

Managing Data Projects

On successful completion, students will be able to

- use agile project management techniques to efficiently manage data-intensive projects.
- design and implement Infrastructure as Code for data-intensive systems.
- organize data-projects with Continuous Integration/Continuous Delivery pipelines.
- apply techniques for efficient collaboration and testing in data-intensive projects.
- explain the concepts and apply the techniques for container communication and networking.
- differentiate and use common tools and frameworks for managing data projects.

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

Managing Data Projects

Course Code: DLMDMMDP01

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

Course Description

Managing data projects in a collaborative, efficient, and modular way, with thorough testing phases and short feedback back loops is a challenge in its own. In this course, students acquire practical knowledge for agile project management in data-intensive projects. The Scrum theory and values are explained as well as its terminology and practical applications for data-intensive projects. Building on this framework, students learn about concepts and their implementations, such as Infrastructure as Code (IaC), Continuous Integration/Continuous Delivery (CI/CD) pipelines, as well as tools and platform solutions for agile data project management. Students learn how to build data systems in a reproducible way by applying principles of IaC with common infrastructure template languages. To build lean data systems with short feedback loops and short product increment cycles, students are enabled to build automated CI/CD pipelines with incremental testing stages, collaborative version control and branching strategies. Most modern data systems are implemented as containerized microservice architectures. In this course, students learn how to ensure a safe and reliable communication between containers and suitable networking setups. Finally, students are enabled to use tools and frameworks for managing data projects in an efficient way and in accordance with the principles which they have learned about in this course.

Course Outcomes

On successful completion, students will be able to

- use agile project management techniques to efficiently manage data-intensive projects.
- design and implement Infrastructure as Code for data-intensive systems.
- organize data-projects with Continuous Integration/Continuous Delivery pipelines.
- apply techniques for efficient collaboration and testing in data-intensive projects.
- explain the concepts and apply the techniques for container communication and networking.
- differentiate and use common tools and frameworks for managing data projects.

Contents

1. Agile Project Management for Data-Intensive Projects
   - 1.1 Data Science Life Cycle
   - 1.2 Scrum Theory and Values
   - 1.3 Scrum Teams in Data-Intensive Projects
   - 1.4 Scrum Events in Data-Intensive Projects
   - 1.5 Scrum Artifacts in Data-Intensive Projects

1.6 Challenges of Scrum for Data-Intensive Projects

2. Infrastructure as Code
   - 2.1 Infrastructure for Data-Intensive Projects
   - 2.2 Principles of Infrastructure as Code
   - 2.3 Terraform
   - 2.4 ARM Templates
   - 2.5 DevOps

3. Testing and Collaboration
   - 3.1 Branching Strategies
   - 3.2 Environments and Stages
   - 3.3 Testing Strategies

4. Continuous Integration/Continuous Delivery
   - 4.1 Concepts of a CI/CD Pipeline
   - 4.2 Building a CI/CD Pipeline for Data-Intensive Systems

5. Container Communication and Networking
   - 5.1 Containers and APIs
   - 5.2 Container Orchestration and Networking

6. Tools for Managing Data Projects
   - 6.1 Overview of Tools for Managing Data Project
   - 6.2 GitHub
   - 6.3 Jenkins

Literature

Compulsory Reading

Further Reading

- Brikman, Y. (2019): Terraform: Up & Running: Writing Infrastructure as Code. 2nd Edtion, O'Reilly, Sebastopol, CA.
- Burns, B./Beda, J., Hightower, K. (2019): Kubernetes: Up and Running: Up and Running. 2nd Edition, O'Reilly, Sebastopol, CA.
- Farcic, V. (2016): The DevOps 2.0 toolkit: Automating the continuous deployment pipeline with containerized microservices. CreateSpace, Independent Publishing Platform, Scotts Valley, CA.
- Gift, N. (2019): Python for DevOps: Learn Ruthlessly Effective Automation. 1st Edition, O'Reilly, Sabastopol, CA.

- Ibryam, B. (2019): Kubernetes Patterns: Reusable Elements for Designing Cloud Native Applications. 1st Edition, O'Reilly, Sebastopol, CA.
- Kane, S. P. (2018): Docker: Up and Running: Shipping Reliable Containers in Production. 1st Edition, O'Reilly, Sebastopol, CA
- Leszko, R. (2019): Continuous Delivery with Docker and Jenkins: Create secure applications by building complete CI/CD pipelines. 2nd Edition, O'Reilly, Sebastopol, CA.
- Loeliger, J. (2012): Version Control with Git: Powerful tools and techniques for collaborative software development. 2nd Edition, O'Reilly, Sebastopol, CA.
- Percival, H. (2017): Test-Driven Development with Python: Obey the Testing Goat: Using Django, Selenium, and JavaScript. O'Reilly, Sebastopol, CA.
- Schwaber, K./Sutherland, J. (2021): Scrum Guide. (URL: https://scrumguides.org/scrum-guide.html, updated on 02.03.2021 [last access: 11.03.2021]).

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	

Seminar: Cloud Providers and Services

Module Code: DLMDMSCPS

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Andrew Adjah Sai (Seminar: Cloud Providers and Services)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Seminar: Cloud Providers and Services (DLMDMSCPS01)

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

Module Contents

Seminar: Cloud Providers and Services

Students acquaint themselves with different cloud providers and learn how to critically assess their portfolios with respect to their suitability for data-intensive projects.

Learning Outcomes

Seminar: Cloud Providers and Services

On successful completion, students will be able to

- design and implement cloud solutions for realistic use cases in an problem-oriented way.
- assess popular cloud providers and their services with respect to the suitability for specific use cases.
- evaluate various up-to-date cloud solution services and build these components into solution architectures.
- investigate cloud providers' documentations and technical material to independently acquire needed information and practical skills for building cloud solutions.

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

Seminar: Cloud Providers and Services

Course Code: DLMDMSCPS01

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

Course Description

For reasons of reliability, scalability and maintainability, many organizations and businesses decide to shift their data-intensive systems to the cloud. There are numerous cloud providers with different service portfolios which are intended to meet specific use cases. In this seminar, students are enabled to critically assess various cloud providers with respect to their service portfolios and suitability for specific data-intensive projects. Students learn how to independently acquaint themselves with new provided cloud technologies and services which are constantly evolving. This way, students learn how to keep their cloud knowledge and skills up-to-date in this rapidly changing context.

Course Outcomes

On successful completion, students will be able to

- design and implement cloud solutions for realistic use cases in an problem-oriented way.
- assess popular cloud providers and their services with respect to the suitability for specific use cases.
- evaluate various up-to-date cloud solution services and build these components into solution architectures.
- investigate cloud providers' documentations and technical material to independently acquire needed information and practical skills for building cloud solutions.

Contents

- The seminar covers an overview and evaluation of current cloud providers and their cloud service portfolios. Each participant must write a seminar paper on a problem-oriented topic with respect to cloud solutions for a specific use case. Students are provided with literature and suitable sources for independently acquiring information and practical skills which are necessary to build cloud solutions within this context.

Literature

Compulsory Reading

Further Reading

- Bala, R./Gill, B./Smith, D./Wright, D./Ji, K. (2020): Gartner Magic Quadrant for Cloud Infrastructure and Platform Services. (URL: https://www.gartner.com/en/documents/3989743/magic-quadrant-for-cloud-infrastructure-and-platform-ser [last accessed: 25.02.2021]) .
- Sweetman, M. (2019): Cloud Service Providers. (URL: https://luneba.com/blog/cloud-service-providers [last accessed: 25.02.2021]) .
- anon. (n. d.): Microsoft Azure Documentation. (URL: https://docs.microsoft.com/en-us/azure/ [last accessed: 25.02.2021]).
- anon. (n. d.): Google Cloud Documentation. (URL: https://cloud.google.com/docs [last accessed: 25.02.2021]).
- anon. (n. d.): Amazon Web Services Documentation. (URL: https://docs.aws.amazon.com/ [last accessed: 25.02.2021]).

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Seminar

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

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

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

Project: Data Engineering

Module Code: DLMDSEDE2

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMDSEDE01	MA	5	150 h

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

Module Coordinator

Prof. Dr. Max Pumperla (Project: Data Engineering)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Project: Data Engineering (DLMDSEDE02)

Module Exam Type

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

Module Contents

Project: Data Engineering

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

Learning Outcomes

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 Programs in the IT & Technology field

Project: Data Engineering

Course Code: DLMDSEDE02

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

Study Format myStudies

Study Format	Course Type
myStudies	Project

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

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

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

3. Semester

Programming with Python

Module Code: DLMDSPWP

Module Type	Admission Requirements	Study Level	ECTS Credits	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)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Programming with Python (DLMDSPWP01)

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

Module Contents

Programming with Python

- Introduction to the Python Programming Language
- Object-Oriented Concepts in Python
- Handling of Exceptions and Errors
- The Python Library Ecosystem
- Environments and Package Management
- Documentation and Testing
- Version Control

Learning Outcomes

Programming with Python

On successful completion, students will be able to

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

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

Programming with Python

Course Code: DLMDSPWP01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 and Packages
2. Classes and Inheritance
   - 2.1 Scopes and Namespaces
   - 2.2 Classes and Inheritance
   - 2.3 Iterators and Generators

3. Python Important Libraries
   - 3.1 Standard Python Library
   - 3.2 Scientific Calculations
   - 3.3 Machine Learning Libraries
   - 3.4 Data 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 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
☑ Recorded Live Sessions	☑ Audio	

Study Format myStudies

Study Format	**Course Type**
myStudies	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
☑ Recorded Live Sessions	☑ Audio	

Project: Data Analysis in the Cloud

Module Code: DLMDMPDAC

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Yan Zhu (Project: Data Analysis in the Cloud)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Project: Data Analysis in the Cloud (DLMDMPDAC01)

Module Exam Type	
Module Exam Study Format: Distance Learning Written Assessment: Project Report	**Split Exam**

Module Contents

Project: Data Analysis in the Cloud

Students learn practical skills to design and implement data analysis pipelines on a prevalent managed cloud analysis platform.

Learning Outcomes

Project: Data Analysis in the Cloud

On successful completion, students will be able to

- explain and use concepts of distributed compute for data analysis in the cloud.
- describe and use concepts and techniques of process parallelization for data analysis in the cloud.
- conduct data analysis in a systematic way using a prevalent framework for tracking experiments and deploying models to the cloud.
- using a managed platform for data analysis in the cloud.

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

Project: Data Analysis in the Cloud

Course Code: DLMDMPDAC01

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

Course Description

The analysis of increasingly large amounts of data makes the detection of patterns and, ultimately, the generation of insight as added value more probable. However, as it is no longer feasible to handle these large datasets on local machines, distributed cloud systems are essential for analysis. Making use of managed data analysis cloud platforms allows to focus on the analysis itself rather than on managing the underlying infrastructure. In this project, students acquire practical skills for distributed and parallel analysis in the cloud. Students learn how to make use of frameworks for experiment tracking, organization, and easy deployment of models to the cloud. Students also learn to confidently use one of the most prevalent managed cloud analysis platforms, such as Databricks, Azure Machine Learning, Google AI Platform or Amazon SageMaker.

Course Outcomes

On successful completion, students will be able to

- explain and use concepts of distributed compute for data analysis in the cloud.
- describe and use concepts and techniques of process parallelization for data analysis in the cloud.
- conduct data analysis in a systematic way using a prevalent framework for tracking experiments and deploying models to the cloud.
- using a managed platform for data analysis in the cloud.

Contents

- In this project, students acquaint themselves with data analysis cloud platforms and related technologies for distributed compute, parallelization, and analysis project organization. Students design a simple data analysis pipeline and implement this process in one of the prevalent managed cloud analysis platforms, such as Databricks, Azure Machine Learning, Google AI Platform or Amazon SageMaker. Students are presented with several realistic use cases from which they choose one to be solved with an analysis platform in the cloud.

Literature

Compulsory Reading

Further Reading

- anon. (n. d.): MLflow Documentation. (URL: https://mlflow.org/docs/latest/index.html [last accessed: 25.02.2021]).
- Ilijason, R. (2020): Beginning Apache Spark Using Azure Databricks. Unleashing Large Cluster Analytics in the Cloud. 1st Edition. Apress, Berkeley, CA.
- Karau, H. (2015): Learning Spark. Lightening fast data analysis. 1st Edition. O'Reilly, Sebastopol, CA.
- Körner, C./Waaijer, K. (2020): Mastering Azure Machine Learning. Perform large-scale end-to-end advanced machine learning in the cloud with Microsoft Azure Machine Learning. Packt Publishing, Birmingham, UK.
- Lanham, M. (2021): Practical AI on the Google Cloud Platform. Utilizing Google's state-of-the-art AI cloud services. 1st Edition. O'Reilly, Sebastopol, CA.
- Simon, J./Pochetti, F. (2020): Learn Amazon SageMaker. A guide to building, training, and deploying machine learning models for developers and data scientists. Packt Publishing. Birmingham, UK.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

Instructional Methods

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

Exam Preparation
☑ Guideline

Data Manager for Internet of Things

Module Code: DLMDMEDMIT

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMBMMIIT01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Christian Müller-Kett (Project: Building an Internet of Things Cloud Solution) / Rachel John Robinson (Internet of Things)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Internet of Things (DLMBMMIIT01)
- Project: Building an Internet of Things Cloud Solution (DLMDMEDMIT01)

Module Exam Type

Module Exam	Split Exam
	Internet of Things • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes Project: Building an Internet of Things Cloud Solution • Study Format "Distance Learning": Written Assessment: Project Report

Module Contents

Project: Building an Internet of Things Cloud Solution

In the project students learn and train practical skills to design and implement working IoT systems on the edge and in the cloud.

Internet of Things

- Consumer use cases and risks
- Business use cases and risks
- Social-economic issues
- Enabling technologies and networking fundamentals

Learning Outcomes

Project: Building an Internet of Things Cloud Solution

On successful completion, students will be able to

- design and implement a production-ready IoT cloud solution from sensor data to reporting.
- automate processes within an IoT environment.
- secure and monitor a cloud-based IoT system.
- assess different cloud providers with respect to their service portfolios for IoT solutions and their suitability for specific use cases.
- use the services of one of the prevalent cloud providers to implement IoT solutions to the cloud.

Internet of Things

On successful completion, students will be able to

- distinguish and discuss a broad range of use cases for the internet of things (IoT).
- understand and reflect upon the different perspectives on IoT.
- apply distinct techniques to engineer internet-of-things products.
- evaluate and identify appropriate IoT communication technology and standards according to given IoT product requirements.
- reflect on the respective theoretical foundation, evaluate different approaches, and apply appropriate approaches to practical questions and cases.

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 Programs in the IT & Technology field

Internet of Things

Course Code: DLMBMMIIT01

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

Course Description

The Internet of Things (IoT), once a rough vision, has become reality today in a broad manner. There is a plethora of devices and services available to both consumers and businesses.
From smart homes to smart cities, from smart devices to smart factories – internet-of-things technologies impact on our lives and environments.
This course follows a top-down approach, discussing a broad set of aspects connected with the internet of things. It starts with use cases and risks from the perspectives of customers and businesses and winds up with a technical foundation of the internet of things. To address the engineering perspective, a set of techniques is proposed.

Course Outcomes

On successful completion, students will be able to

- distinguish and discuss a broad range of use cases for the internet of things (IoT).
- understand and reflect upon the different perspectives on IoT.
- apply distinct techniques to engineer internet-of-things products.
- evaluate and identify appropriate IoT communication technology and standards according to given IoT product requirements.
- reflect on the respective theoretical foundation, evaluate different approaches, and apply appropriate approaches to practical questions and cases.

Contents

1. Introduction into the Internet of Things
   - 1.1 Foundations and Motivations
   - 1.2 Potential and Challenges
2. Social and Business Relevance
   - 2.1 Innovations for Consumers and Industry
   - 2.2 Impact on Human and Work Environment
   - 2.3 Privacy and Security
3. Architectures of Internet of Things and Industrial Internet of Things
   - 3.1 Elements of IoTs and IIoTs
   - 3.2 Sensors and Nodes

3.3 Power Systems
3.4 Fog Processors
3.5 Platforms

4. Communication Standards and Technologies
   4.1 Network Topologies
   4.2 Network Protocols
   4.3 Communication Technologies

5. Data Storage and Processing
   5.1 NoSQL and MapReduce
   5.2 Linked Data and RDF(S)
   5.3 Semantic Reasoning
   5.4 Complex Event Processing
   5.5 Machine Learning
   5.6 Overview of Existing Data Storage and Processing Platforms

6. Fields of Application
   6.1 Smart Home/Living
   6.2 Smart Buildings
   6.3 Ambient Assisted Living
   6.4 Smart Energy/Grid
   6.5 Smart Factory
   6.6 Smart Logistics
   6.7 Smart Healthcare
   6.8 Smart Agriculture

Literature

Compulsory Reading

Further Reading

- Lea, P. (2018). Internet of things for architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. Birmingham: Packt Publishing Ltd. (Database: Dawson).
- McEwen, A., & Cassimally, H. (2013). Designing the internet of things. Chichester: John Wiley & Sons. (Database: ProQuest).
- Raj, P., & Raman, A. C. (2017). The Internet of Things: Enabling technologies, platforms, and use cases. Boca Raton, FL: Auerbach Publications. (Database: ProQuest).
- Weber, R. H., & Weber, R. (2010). Internet of Things. Heidelberg: Springer. (Database: Dawson).

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	

Study Format myStudies

Study Format	**Course Type**
myStudies	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	

Project: Building an Internet of Things Cloud Solution

Course Code: DLMDMEDMIT01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	Admission Requirements
MA	English		5	DLMBMMIIT01

Course Description

The Internet of Things (IoT) has become reality in many organizations, businesses, and various parts of our everyday lives. In this project, students acquire practical skills to design and implement a working IoT solution on the edge and in the cloud. Students practically train to automate processes within IoT settings as well as securing and monitoring these systems. There are numerous cloud providers with IoT services in their portfolios. In this project, students learn to critically assess the suitability of the service portfolios of different cloud providers.

Course Outcomes

On successful completion, students will be able to

- design and implement a production-ready IoT cloud solution from sensor data to reporting.
- automate processes within an IoT environment.
- secure and monitor a cloud-based IoT system.
- assess different cloud providers with respect to their service portfolios for IoT solutions and their suitability for specific use cases.
- use the services of one of the prevalent cloud providers to implement IoT solutions to the cloud.

Contents

- In this project, students acquaint themselves with different cloud providers and their IoT service offerings. Students learn to evaluate which cloud provider fits best for a specific practical IoT use case. Ultimately, students practically train to design and implement a working IoT system in the cloud. Students are presented with several realistic use cases from which they choose one to be solved with IoT techniques. The students independently choose suitable techniques and conduct the IoT project in a problem-oriented manner.

Literature

Compulsory Reading

Further Reading

- Borycki, D. (2017): Programming for the Internet of Things. Using Windows 10 IoT core and Azure IoT Suite. Microsoft Press, Redmond, WA.

- Klein, S. (2017): IoT solutions in Microsofts Azure IoT Suite - data acquisition and analysis. Data Acquisition and Analysis in the Real World. Apress, New York, NY.
- Lea, P. (2020): Internet of Things for architects. Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. 2nd Edition. Packt Publishing, Birmingham, UK.
- Patil, Y. (2017): Azure IoT Development Cookbook. Develop and manage robust IoT solutions. Packt Publishing, Birmingham, UK.
- Rossman, J. (2016): The Amazon way on IoT. 10 principles for every leader from the world's leading Internet of things strategies. Clyde Hill Publishing, Bellevue, WA.
- Smart, G. (2020): Practical Python Programming for IoT. 1st Edition. Packt Publishing, Birmingham, UK.
- Veneri, G./Capasso, A. (2018): Hands-On Industrial Internet of Things. Create a powerful industrial IoT infrastructure using industry 4.0. Packt Publishing, Birmingham, UK.
- anon. (n. d.): Microsoft Azure IoT Documentation (URL: https://docs.microsoft.com/en-us/azure/iot-fundamentals/ [last accessed: 25.02.2020]).
- anon. (n. d.): Google IoT Documentation (URL: https://cloud.google.com/iot/docs [last accessed: 25.02.2020]).
- anon. (n. d.): AWS IoT Documentation (URL: https://docs.aws.amazon.com/iot/index.html [last accessed: 25.02.2020]).

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Data Miner

Module Code: DLMDMEDM

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMDMEDM01	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. Frank Passing (Leveraging Data Sources & Data Mining) / Prof. Dr. Neil Arvin Bretana (Project: Leveraging Data Sources & Data Mining)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Leveraging Data Sources & Data Mining (DLMDMEDM01)
- Project: Leveraging Data Sources & Data Mining (DLMDMEDM02)

Module Exam Type

Module Exam	Split Exam
	Leveraging Data Sources & Data Mining • Study Format "Distance Learning": Exam, 90 Minutes Project: Leveraging Data Sources & Data Mining • Study Format "Distance Learning": Written Assessment: Project Report

Module Contents

Leveraging Data Sources & Data Mining

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

Project: Leveraging Data Sources & Data Mining

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

Learning Outcomes

Leveraging Data Sources & Data Mining

On successful completion, students will be able to

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

Project: Leveraging Data Sources & Data Mining

On successful completion, students will be able to

- implement a data mining project using Python.
- practice and refine the learned knowledge.
- explore, transfer, convert and experiment with different types of data.
- evaluate the outcomes of the data mining project.
- demonstrate meaningful use of technical skills by documentation.
- present the major techniques of data mining and all related procedures.

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

Leveraging Data Sources & Data Mining

Course Code: DLMDMEDM01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

1. Data Mining Process
   - 1.1 The Role of Data in Businesses
   - 1.2 Understanding Data
   - 1.3 Modeling
   - 1.4 Evaluation
   - 1.5 Deployment
2. Data Quality and Data Preparation
   - 2.1 Gathering Data
   - 2.2 Data Selection
   - 2.3 Data Cleansing
   - 2.4 Sparse Data and Missing Values
   - 2.5 Data Consistency

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

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

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

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

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

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

8.4 Data Protection and Transparency

8.5 Copyright Compliance

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	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	

Project: Leveraging Data Sources & Data Mining

Course Code: DLMDMEDM02

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	Admission Requirements
MA	English		5	DLMDMEDM01

Course Description

The focus of this course is to apply previously acquired data mining knowledge to a project implementation and reflect on the results. Students will carry out this project and document the results. In doing so, they reflect on the data mining concepts applied and the impact of these concepts on the success of the project.

Course Outcomes

On successful completion, students will be able to

- implement a data mining project using Python.
- practice and refine the learned knowledge.
- explore, transfer, convert and experiment with different types of data.
- evaluate the outcomes of the data mining project.
- demonstrate meaningful use of technical skills by documentation.
- present the major techniques of data mining and all related procedures.

Contents

- In this course, students conduct and document a data mining project using the topics covered in previous module using Python.

Literature

Compulsory Reading

Further Reading

- Greeneltch, Nathan. (2019): Python Data Mining Quick Start Guide: A beginner's guide to extracting valuable insights from your data. Packt Publishing.
- Mitchell, Ryan. (2018): Web Scraping with Python. O'Reilly Media, Inc.
- Porcu, Valentina. (2018): Python for Data Mining Quick Syntax Reference. Apress Media LLC.
- Tan, Pang-Ning / Steinbach, Michael / Kumar, Vipin / Karpatne , Anuj. (2019): Introduction to Data Mining. Addison Wesley.
- Bramer, Max. (2020): Principles of Data Mining. Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Data Security & Protection Specialist

Module Code: DLMDMEDSPS

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMCSITSDP01	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

Tareef Bint Ayaz Lodhi (Project: Securing Data-Intensive Systems) / Prof. Dr. Ralf Kneuper (Cyber Security and Data Protection)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Cyber Security and Data Protection (DLMCSITSDP01)
- Project: Securing Data-Intensive Systems (DLMDMEDSPS01)

Module Exam Type

Module Exam	Split Exam
	Cyber Security and Data Protection • Study Format "Distance Learning": Oral Assignment • Study Format "myStudies": Oral Assignment Project: Securing Data-Intensive Systems • Study Format "Distance Learning": Oral Project Report

Module Contents

Project: Securing Data-Intensive Systems

Data-intensive systems are a technological building block supporting big data and data science applications. Given their degree of specialization, data-intensive systems pose special security and data protection challenges to practitioners. The course aims to apply the cyber-security and data protection foundations commonly associated to data-intensive systems.

Cyber Security and Data Protection

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

Learning Outcomes

Project: Securing Data-Intensive Systems

On successful completion, students will be able to

- elicit cyber-security and data protection requirements for the data-intensive system under consideration, and model the relevant threats.
- identify and apply relevant standards and regulations, in the areas of cyber-security and data protection, to a data-intensive system.
- design a security architecture taking on the computationally intensive tasks of a target big data system in the selected application field.
- develop criteria to evaluate and select the techniques fulfilling the elicited cyber-security and data protection requirements associated to data-intensive systems in at least one specific application field.
- develop a cyber-security concept covering the whole life-cycle of the data-intensive system, from threat modelling to data disposal.
- implement and monitor measures for data security and protection and to report their cyber-security reference implementation for at least one real-world data-intensive system.

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 Programs in the IT & Technology field

Cyber Security and Data Protection

Course Code: DLMCSITSDP01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 Endpoint Security
   - 4.3 Cyber Security in Networks
   - 4.4 Developing Secure IT Systems

5. Cyber Security Management
   - 5.1 Security Policy
   - 5.2 Security and Risk Analysis
   - 5.3 The ISO/IEC 27K 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 Elliptic-Curve Cryptography
   - 6.4 Hash Functions
   - 6.5 Secure Key Exchange

7. Cryptographic Applications
   - 7.1 Digital Signatures
   - 7.2 Secure Internet Protocols
   - 7.3 Blockchain
   - 7.4 Electronic Money

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 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	☑ Audio	

Study Format myStudies

Study Format	Course Type
myStudies	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
- ☑ Audio

Exam Preparation
- ☑ Online Tests
- ☑ Guideline

Project: Securing Data-Intensive Systems

Course Code: DLMDMEDSPS01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	Admission Requirements
MA	English		5	DLMCSITSDP01

Course Description

Data-intensive systems relate to a particular set of computing applications which process large volumes of data (typically terabytes or petabytes in size), which are referred to as “big data” and are typically leveraged in data science applications. The underlying computational paradigms associated to data-intensive systems (e.g., Cloud Computing, Internet of Things or Apache Spark) bring their own cyber-security and data protection requirements and challenges. In this project, students will have the opportunity to apply cyber-security and data protection best-practices to a real-world data-intensive system including but not limited to:

Course Outcomes

On successful completion, students will be able to

- elicit cyber-security and data protection requirements for the data-intensive system under consideration, and model the relevant threats.
- identify and apply relevant standards and regulations, in the areas of cyber-security and data protection, to a data-intensive system.
- design a security architecture taking on the computationally intensive tasks of a target big data system in the selected application field.
- develop criteria to evaluate and select the techniques fulfilling the elicited cyber-security and data protection requirements associated to data-intensive systems in at least one specific application field.
- develop a cyber-security concept covering the whole life-cycle of the data-intensive system, from threat modelling to data disposal.
- implement and monitor measures for data security and protection and to report their cyber-security reference implementation for at least one real-world data-intensive system.

Contents

- Given a real-world application scenario involving a data-intensive system (e.g., an IoT system with cloud-based storage, streaming analysis, and reporting capabilities), the students will develop a security concept encompassing its whole life-cycle. Starting with a focused threat modelling (identifying common risks associated to the usage of big data) and following with the elicitation of cyber-security and data protection measures, the students will propose a framework for securing the chosen data-intensive system. Furthermore, the proposed

cyber-security and data protection framework (comprising processes and tools) should also document a reference implementation for at least one of the subsystems comprising the data-intensive system.

Literature

Compulsory Reading

Further Reading

- Anderson, R. (2020): Security Engineering. A Guide to Building Dependable Distributed Systems. 3rd ed., John Wiley & Sons, United States of America.
- Chen, P. et al. (2014): Data-intensive applications, challenges, techniques and technologies. In: ScienceDirect Journal of Information Sciences, vol. 275, p. 314-347.
- Fernandez E. (2011): Security in Data Intensive Computing Systems. In: Handbook of Data Intensive Computing, p. 447-466.
- Jones, B. et al. (2019): HNSciCloud. A Hybrid Cloud for Science. In: Proceedings of the CHEP 2018 conference, volume 214, p. 1-8.
- Kehuan, Z. et al. (2011): Sedic. Privacy-aware data intensive computing on hybrid clouds. In: Proceedings of the 18th ACM conference on Computer and communications security, CCS '11, p. 515–526.
- Choo, R. et al. (2020): Handbook of Big Data Privacy. Springer-Verlag, United States of America.
- Kleppmann, M. (2017): Designing Data-Intensive Applications. The Big Ideas Behind Reliable, Scalable, and Maintainable Systems. O'Reilly Media Inc., United States of America.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Oral Project Report

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

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

Data Scientist

Module Code: DLMDMEDS-01

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMBDSA01-01	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. Gissel Velarde (Data Science) / Prof. Dr. Neil Arvin Bretana (Project: Applied Data Science)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Data Science (DLMBDSA01-01)
- Project: Applied Data Science (DLMDMEDS01)

Module Exam Type

Module Exam	Split Exam
	Data Science • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes Project: Applied Data Science • Study Format "Distance Learning": Oral Project Report

Module Contents

Data Science

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

Project: Applied Data Science

In the project students learn to independently organize and practically conduct all steps of a Data Science project from scratch to a production-ready model.

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.

Project: Applied Data Science

On successful completion, students will be able to

- assess and choose suitable techniques for data preprocessing and modeling with respect to a specific use case and available data.
- apply concepts and techniques in data science to real life use cases.
- independently organize a Data Science project.

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

Data Science

Course Code: DLMBDSA01-01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 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		

Study Format myStudies

Study Format	Course Type
myStudies	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		

Project: Applied Data Science

Course Code: DLMDMEDS01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	Admission Requirements
MA	English		5	DLMBDSA01-01

Course Description

Students train their skills in assessing suitable Data Science techniques and frameworks for a specific real-life use case. By doing so, students consider the available data, explore the data in terms of its statical metrics and missing values and conduct necessary preprocessing steps. Students define suitable model KPIs, perform all necessary steps to build a base line model which is then improved by informed decisions about alternative modeling algorithms, feature engineering and hyperparameter tuning. In this project, students train their practical skills as well as their critical judgment with respect to suitable Data Science techniques for, ultimately, creating added value for organizations and businesses.

Course Outcomes

On successful completion, students will be able to

- assess and choose suitable techniques for data preprocessing and modeling with respect to a specific use case and available data.
- apply concepts and techniques in data science to real life use cases.
- independently organize a Data Science project.

Contents

- In this project, students acquaint themselves with the practical application of Data Science frameworks and techniques in real-life projects. Students are presented with a number of realistic use cases from which they choose one to be solved with Data Science techniques. The students independently choose suitable techniques and conduct the Data Science project in a problem-oriented manner.

Literature

Compulsory Reading

Further Reading

- Géron, A. (2017): Hands-on Machine Learning with Scikit-Learn and TensorFlow. Concepts, tools, and techniques to build intelligent systems. 1st Edition. O'Reilly, Sebastopol, CA.
- Grus, J. (2019): Data Science from Scratch. 2nd Edition. O'Reilly, Sebastopol, CA.
- McKinney, W. (2017): Python for Data Analysis. Data wrangling with Pandas, NumPy, and IPython. 2nd Edition. O'Reilly, Sebastopol, CA.

- VanderPlas, J. (2016): Python Data Science Handbook. Essential tools for working with data. 1st Edition. O'Reilly, Sebastopol, CA.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Oral Project Report

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

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

Business Analyst

Module Code: DLMDSEBA

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMDSEBA01	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) / Prof. Dr. Silke Vaas (Project: Business Intelligence)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Business Intelligence (DLMDSEBA01) ▪ Project: Business Intelligence (DLMDSEBA02)

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

Module Contents

Business Intelligence

- 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

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

Course Code: DLMDSEBA01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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	

Study Format myStudies

Study Format	**Course Type**
myStudies	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		

Project: Business Intelligence

Course Code: DLMDSEBA02

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

Study Format myStudies

Study Format	Course Type
myStudies	Project

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

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

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

Technical Project Lead

Module Code: DLMDSETPL

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMBITPAM01	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. Carsten Skerra (IT Project Management) / Prof. Dr. Dorian Mora (Project: Technical Project Planning)
Information about the Module Coordinator without guarantee

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 • Study Format "myStudies": Exam, 90 Minutes Project: Technical Project Planning • Study Format "Distance Learning": Portfolio • Study Format "myStudies": Portfolio

Module Contents

IT Project Management

- Organizing the work
- Cost estimation and controlling
- The human factor
- Organizing small and medium projects
- Organizing 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	ECTS Credits	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		

Study Format myStudies

Study Format	Course Type
myStudies	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		

Project: Technical Project Planning

Course Code: DLMDSETPL01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

Study Format myStudies

Study Format	Course Type
myStudies	Project

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

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

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

Process Management and Operational Application Systems

Module Code: DLMWIWPBA_E

Module Type	Admission Requirements	Study Level	ECTS Credits	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
Uma Santhosh Tumpala (Process Management) / Prof. Dr. Maik Drozdzynski (Operational Application Systems)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Process Management (DLMWIWPBA01_E) ▪ Operational Application Systems (DLMWIWPBA02_E)

Module Exam Type	
Module Exam	**Split Exam** Process Management • Study Format "Distance Learning": Exam, 90 Minutes Operational Application Systems • Study Format "Distance Learning": Written Assessment: Case Study

Module Contents

Process Management

- Terms and Motivation for Process Management
- Strategic Process Management
- Modeling of Business Processes
- Process Controlling
- Process Roll-Out
- Process Optimization

Operational Application Systems

- Categories of Operational Application Systems
- Business Process Management Systems
- Enterprise Resource Planning
- Supply Chain Management
- Customer Relationship Management
- Management Information Systems

Learning Outcomes

Process Management

On successful completion, students will be able to

- describe motivation of process management, delineate typical processes of design phases, and identify risks of process change.
- document business processes in a structured manner.
- describe the motivation and use of reference processes and name at least one typical reference process.
- describe and exemplify required activities in the reengineering of processes.
- describe phases of a process roll-out, analyze effects of process changes and identify risks.

Operational Application Systems

On successful completion, students will be able to

- describe and differentiate categories of business application systems.
- describe and differentiate typical tasks and functions of systems for business process management, workflow management and document management.
- describe the motivation and objectives of ERP systems and evaluate how they
- support the planning and control of operational and strategic resources.
- state and delineate objectives, functions, and an example scenario for supply chain management systems.
- describe objectives, functions, and an example scenario for customer relationship management systems.
- describe and differentiate the use and information structure of analytical information systems and their applications for management information.
- analyze and evaluate for given scenarios which business functions can be usefully deployed by which types of operational application systems and to describe the knowledge gained.

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 Programs in the IT & Technology field

Process Management

Course Code: DLMWIWPBA01_E

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

Course Description

Well-defined business processes are a central basis for the control and management of medium-sized and large organizations. They contain binding rules and agreements documenting the interaction of all organizational units and persons involved. In this course, practical documentation methods for process modeling and the use of reference processes are presented. In addition a discussion of phases and activities for reengineering processes is given which can then be used to redesign existing corporate processes. Subsequently, the course informs about organizational change and how it can be carried out with a process roll-out and what has to be considered in the process. Finally, the motivation, elements and results of strategic process management are presented and their relationships with corporate organization are explained.

Course Outcomes

On successful completion, students will be able to

- describe motivation of process management, delineate typical processes of design phases, and identify risks of process change.
- document business processes in a structured manner.
- describe the motivation and use of reference processes and name at least one typical reference process.
- describe and exemplify required activities in the reengineering of processes.
- describe phases of a process roll-out, analyze effects of process changes and identify risks.

Contents

1. Terms and Motivation for Process Management
   - 1.1 Terms: Process, Process Management
   - 1.2 Motivation for Process Management
   - 1.3 Risks and Challenges of Changing Processes in Organizations
   - 1.4 Phases of Process Design
   - 1.5 From Process to Workflow

2. Strategic Process Management
   - 2.1 Organizational Forms and Their Development
   - 2.2 Derivation of Enterprise Process Models
   - 2.3 Design and Structuring of Enterprise Process Models

2.4 Process Landscape and Process Maps
2.5 Reference Processes (ITIL, CMM as an Example)

3. Modeling of Business Processes
   3.1 Actual and Target Modeling
   3.2 Business Process and Notation (BPMN)
   3.3 Extended Event Driven Process Chains (eEPC)

4. Process Controlling
   4.1 The PDCA Approach and CIP
   4.2 Process Controlling, KPIs, Metrics, Dimensions
   4.3 Process Mining

5. Process Roll-Out
   5.1 Phases of a Process Roll-Out
   5.2 5.2 Simulation of Processes

6. Process Optimization
   6.1 State-Analysis and Process Evaluation
   6.2 Process Optimization
   6.3 Analysis of the Effects of Process Changes
   6.4 Change Management

Literature

Compulsory Reading

Further Reading

- Becker, J./Kugeler, M./Rosemann, M. (2011): Process Management. A Guide for the Design of Business Processes. 2nd Edition. Springer, Berlin/Heidelberg.
- Damij, N., Damij, T. (2014): Process Management. A Multi-disciplinary Guide to Theory, Modeling, and Methodology. Springer, Berlin/Heidelberg.
- Davis, R. (2008): ARIS Design Platform: Getting Started with BPM. Springer, London.
- Freund, J./Rücker, B. (2019): Real-Life BPMN. Includes an introduction to DMN. 4th Edition. Independently published.
- Hanschke, I. (2010): Strategic IT Management: A Toolkit for Enterprise Architecture Management. Springer, Berlin/Heidelberg.
- Process Maps (2019): IT Process Wiki - the ITIL®-Wiki. This Wiki is about the IT Infrastructure Library ITIL® (ITIL 4, ITIL V3 & V2) and IT Service Management (ITSM). (URL: https://wiki.en.it-processmaps.com/index.php/Main_Page [last access: 2021-02-16]).

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
	☑ Audio	

Operational Application Systems

Course Code: DLMWIWPBA02_E

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

Course Description

Almost every company uses operational application systems to perform or support business processes. In addition, many management decisions are made on the basis of data which is provided and evaluated by business application systems. This course first describes the categories of operational application systems and the business units in which they are used. Then, typical tasks and functions of systems for business process management, workflow management and document management are described.
In addition, tasks, functions and example scenarios for enterprise resource planning, supply chain management and customer relationship management systems are presented. Finally, analytical information systems and their applications as management information systems are described.

Course Outcomes

On successful completion, students will be able to

- describe and differentiate categories of business application systems.
- describe and differentiate typical tasks and functions of systems for business process management, workflow management and document management.
- describe the motivation and objectives of ERP systems and evaluate how they
- support the planning and control of operational and strategic resources.
- state and delineate objectives, functions, and an example scenario for supply chain management systems.
- describe objectives, functions, and an example scenario for customer relationship management systems.
- describe and differentiate the use and information structure of analytical information systems and their applications for management information.
- analyze and evaluate for given scenarios which business functions can be usefully deployed by which types of operational application systems and to describe the knowledge gained.

Contents

1. Categories of Operational Application Systems
   - 1.1 Terms, Objectives and Delimitation of Operational Application Systems
   - 1.2 Horizontal and Vertical Integration
   - 1.3 Example Scenario for the Use of Operational Application Systems
2. Systems for Handling Business Processes

2.1 Business Process Management Systems
2.2 Workflow Management Systems
2.3 Document Management Systems

3. Enterprise Resource Planning
   3.1 Motivation and Goals of Enterprise Resource Planning Systems
   3.2 Planning and Control of Operational Resources
   3.3 Planning and Control of Strategic Resources

4. Supply Chain Management
   4.1 Motivation and Objectives of Supply Chain Management Systems
   4.2 General Principles and Challenges in SCM
   4.3 Functions of SCM Systems
   4.4 Example Scenario for the Use of SCM Systems

5. Customer Relationship Management
   5.1 Motivation and Goals of Systems to CRM
   5.2 General Tasks of CRM
   5.3 Example Scenario for the Use of CRM Systems

6. Management Information Systems
   6.1 Analytical Information Systems and their Applications
   6.2 Information Structure from a Management Perspective
   6.3 Example Scenario for the Use of Management Information Systems

Literature

Compulsory Reading

Further Reading

- Bocij, P. (2018): Business Information Systems: Technology, Development and Management for the Modern Business. 6th Edition. Pearson.
- Kurbel, K. (2013): Enterprise Resource Planning and Supply Chain Management: Functions, Business Processes and Software for Manufacturing Companies (Progress in IS). Springer, London.
- Sharda, R. (2017). Business Intelligence, Analytics and Data Science: A Managerial Perspective. 4th Edition. Pearson.
- Vom Brocke, J., Simons, A. (2016): Enterprise Content Management in Information Systems Research: Foundations, Methods and Cases (Progress in IS). Springer, Heidelberg, New York.

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
	☑ Audio	

Data Manager for Internet of Things

Module Code: DLMDMEDMIT

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMBMMIIT01	MA	10	300 h

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

Module Coordinator

Prof. Dr. Christian Müller-Kett (Project: Building an Internet of Things Cloud Solution) / Rachel John Robinson (Internet of Things)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Internet of Things (DLMBMMIIT01)
- Project: Building an Internet of Things Cloud Solution (DLMDMEDMIT01)

Module Exam Type

Module Exam	Split Exam
	Internet of Things • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes Project: Building an Internet of Things Cloud Solution • Study Format "Distance Learning": Written Assessment: Project Report

Module Contents

Project: Building an Internet of Things Cloud Solution

In the project students learn and train practical skills to design and implement working IoT systems on the edge and in the cloud.

Internet of Things

- Consumer use cases and risks
- Business use cases and risks
- Social-economic issues
- Enabling technologies and networking fundamentals

Learning Outcomes

Project: Building an Internet of Things Cloud Solution

On successful completion, students will be able to

- design and implement a production-ready IoT cloud solution from sensor data to reporting.
- automate processes within an IoT environment.
- secure and monitor a cloud-based IoT system.
- assess different cloud providers with respect to their service portfolios for IoT solutions and their suitability for specific use cases.
- use the services of one of the prevalent cloud providers to implement IoT solutions to the cloud.

Internet of Things

On successful completion, students will be able to

- distinguish and discuss a broad range of use cases for the internet of things (IoT).
- understand and reflect upon the different perspectives on IoT.
- apply distinct techniques to engineer internet-of-things products.
- evaluate and identify appropriate IoT communication technology and standards according to given IoT product requirements.
- reflect on the respective theoretical foundation, evaluate different approaches, and apply appropriate approaches to practical questions and cases.

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 Programs in the IT & Technology field

Internet of Things

Course Code: DLMBMMIIT01

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

Course Description

The Internet of Things (IoT), once a rough vision, has become reality today in a broad manner. There is a plethora of devices and services available to both consumers and businesses.
From smart homes to smart cities, from smart devices to smart factories – internet-of-things technologies impact on our lives and environments.
This course follows a top-down approach, discussing a broad set of aspects connected with the internet of things. It starts with use cases and risks from the perspectives of customers and businesses and winds up with a technical foundation of the internet of things. To address the engineering perspective, a set of techniques is proposed.

Course Outcomes

On successful completion, students will be able to

- distinguish and discuss a broad range of use cases for the internet of things (IoT).
- understand and reflect upon the different perspectives on IoT.
- apply distinct techniques to engineer internet-of-things products.
- evaluate and identify appropriate IoT communication technology and standards according to given IoT product requirements.
- reflect on the respective theoretical foundation, evaluate different approaches, and apply appropriate approaches to practical questions and cases.

Contents

1. Introduction into the Internet of Things
   - 1.1 Foundations and Motivations
   - 1.2 Potential and Challenges
2. Social and Business Relevance
   - 2.1 Innovations for Consumers and Industry
   - 2.2 Impact on Human and Work Environment
   - 2.3 Privacy and Security
3. Architectures of Internet of Things and Industrial Internet of Things
   - 3.1 Elements of IoTs and IIoTs
   - 3.2 Sensors and Nodes

3.3 Power Systems
3.4 Fog Processors
3.5 Platforms

4. Communication Standards and Technologies
   4.1 Network Topologies
   4.2 Network Protocols
   4.3 Communication Technologies

5. Data Storage and Processing
   5.1 NoSQL and MapReduce
   5.2 Linked Data and RDF(S)
   5.3 Semantic Reasoning
   5.4 Complex Event Processing
   5.5 Machine Learning
   5.6 Overview of Existing Data Storage and Processing Platforms

6. Fields of Application
   6.1 Smart Home/Living
   6.2 Smart Buildings
   6.3 Ambient Assisted Living
   6.4 Smart Energy/Grid
   6.5 Smart Factory
   6.6 Smart Logistics
   6.7 Smart Healthcare
   6.8 Smart Agriculture

Literature

Compulsory Reading

Further Reading

- Lea, P. (2018). Internet of things for architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. Birmingham: Packt Publishing Ltd. (Database: Dawson).
- McEwen, A., & Cassimally, H. (2013). Designing the internet of things. Chichester: John Wiley & Sons. (Database: ProQuest).
- Raj, P., & Raman, A. C. (2017). The Internet of Things: Enabling technologies, platforms, and use cases. Boca Raton, FL: Auerbach Publications. (Database: ProQuest).
- Weber, R. H., & Weber, R. (2010). Internet of Things. Heidelberg: Springer. (Database: Dawson).

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	

Study Format myStudies

Study Format	Course Type
myStudies	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	

Project: Building an Internet of Things Cloud Solution

Course Code: DLMDMEDMIT01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	Admission Requirements
MA	English		5	DLMBMMIIT01

Course Description

The Internet of Things (IoT) has become reality in many organizations, businesses, and various parts of our everyday lives. In this project, students acquire practical skills to design and implement a working IoT solution on the edge and in the cloud. Students practically train to automate processes within IoT settings as well as securing and monitoring these systems. There are numerous cloud providers with IoT services in their portfolios. In this project, students learn to critically assess the suitability of the service portfolios of different cloud providers.

Course Outcomes

On successful completion, students will be able to

- design and implement a production-ready IoT cloud solution from sensor data to reporting.
- automate processes within an IoT environment.
- secure and monitor a cloud-based IoT system.
- assess different cloud providers with respect to their service portfolios for IoT solutions and their suitability for specific use cases.
- use the services of one of the prevalent cloud providers to implement IoT solutions to the cloud.

Contents

- In this project, students acquaint themselves with different cloud providers and their IoT service offerings. Students learn to evaluate which cloud provider fits best for a specific practical IoT use case. Ultimately, students practically train to design and implement a working IoT system in the cloud. Students are presented with several realistic use cases from which they choose one to be solved with IoT techniques. The students independently choose suitable techniques and conduct the IoT project in a problem-oriented manner.

Literature

Compulsory Reading

Further Reading

- Borycki, D. (2017): Programming for the Internet of Things. Using Windows 10 IoT core and Azure IoT Suite. Microsoft Press, Redmond, WA.

- Klein, S. (2017): IoT solutions in Microsofts Azure IoT Suite - data acquisition and analysis. Data Acquisition and Analysis in the Real World. Apress, New York, NY.
- Lea, P. (2020): Internet of Things for architects. Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security. 2nd Edition. Packt Publishing, Birmingham, UK.
- Patil, Y. (2017): Azure IoT Development Cookbook. Develop and manage robust IoT solutions. Packt Publishing, Birmingham, UK.
- Rossman, J. (2016): The Amazon way on IoT. 10 principles for every leader from the world's leading Internet of things strategies. Clyde Hill Publishing, Bellevue, WA.
- Smart, G. (2020): Practical Python Programming for IoT. 1st Edition. Packt Publishing, Birmingham, UK.
- Veneri, G./Capasso, A. (2018): Hands-On Industrial Internet of Things. Create a powerful industrial IoT infrastructure using industry 4.0. Packt Publishing, Birmingham, UK.
- anon. (n. d.): Microsoft Azure IoT Documentation (URL: https://docs.microsoft.com/en-us/azure/iot-fundamentals/ [last accessed: 25.02.2020]).
- anon. (n. d.): Google IoT Documentation (URL: https://cloud.google.com/iot/docs [last accessed: 25.02.2020]).
- anon. (n. d.): AWS IoT Documentation (URL: https://docs.aws.amazon.com/iot/index.html [last accessed: 25.02.2020]).

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Data Miner

Module Code: DLMDMEDM

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMDMEDM01	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. Frank Passing (Leveraging Data Sources & Data Mining) / Prof. Dr. Neil Arvin Bretana (Project: Leveraging Data Sources & Data Mining)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Leveraging Data Sources & Data Mining (DLMDMEDM01)
- Project: Leveraging Data Sources & Data Mining (DLMDMEDM02)

Module Exam Type

Module Exam	Split Exam
	Leveraging Data Sources & Data Mining • Study Format "Distance Learning": Exam, 90 Minutes Project: Leveraging Data Sources & Data Mining • Study Format "Distance Learning": Written Assessment: Project Report

Module Contents

Leveraging Data Sources & Data Mining

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

Project: Leveraging Data Sources & Data Mining

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

Learning Outcomes

Leveraging Data Sources & Data Mining

On successful completion, students will be able to

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

Project: Leveraging Data Sources & Data Mining

On successful completion, students will be able to

- implement a data mining project using Python.
- practice and refine the learned knowledge.
- explore, transfer, convert and experiment with different types of data.
- evaluate the outcomes of the data mining project.
- demonstrate meaningful use of technical skills by documentation.
- present the major techniques of data mining and all related procedures.

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

Leveraging Data Sources & Data Mining

Course Code: DLMDMEDM01

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

Course Description

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

Course Outcomes

On successful completion, students will be able to

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

Contents

1. Data Mining Process
   - 1.1 The Role of Data in Businesses
   - 1.2 Understanding Data
   - 1.3 Modeling
   - 1.4 Evaluation
   - 1.5 Deployment
2. Data Quality and Data Preparation
   - 2.1 Gathering Data
   - 2.2 Data Selection
   - 2.3 Data Cleansing
   - 2.4 Sparse Data and Missing Values
   - 2.5 Data Consistency

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

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

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

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

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

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

8.4 Data Protection and Transparency

8.5 Copyright Compliance

Literature

Compulsory Reading

Further Reading

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

Study Format Distance Learning

Study Format	Course Type
Distance Learning	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	

Project: Leveraging Data Sources & Data Mining

Course Code: DLMDMEDM02

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	Admission Requirements
MA	English		5	DLMDMEDM01

Course Description

The focus of this course is to apply previously acquired data mining knowledge to a project implementation and reflect on the results. Students will carry out this project and document the results. In doing so, they reflect on the data mining concepts applied and the impact of these concepts on the success of the project.

Course Outcomes

On successful completion, students will be able to

- implement a data mining project using Python.
- practice and refine the learned knowledge.
- explore, transfer, convert and experiment with different types of data.
- evaluate the outcomes of the data mining project.
- demonstrate meaningful use of technical skills by documentation.
- present the major techniques of data mining and all related procedures.

Contents

- In this course, students conduct and document a data mining project using the topics covered in previous module using Python.

Literature

Compulsory Reading

Further Reading

- Greeneltch, Nathan. (2019): Python Data Mining Quick Start Guide: A beginner's guide to extracting valuable insights from your data. Packt Publishing.
- Mitchell, Ryan. (2018): Web Scraping with Python. O'Reilly Media, Inc.
- Porcu, Valentina. (2018): Python for Data Mining Quick Syntax Reference. Apress Media LLC.
- Tan, Pang-Ning / Steinbach, Michael / Kumar, Vipin / Karpatne , Anuj. (2019): Introduction to Data Mining. Addison Wesley.
- Bramer, Max. (2020): Principles of Data Mining. Springer.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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

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

Data Security & Protection Specialist

Module Code: DLMDMEDSPS

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMCSITSDP01	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

Tareef Bint Ayaz Lodhi (Project: Securing Data-Intensive Systems) / Prof. Dr. Ralf Kneuper (Cyber Security and Data Protection)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Cyber Security and Data Protection (DLMCSITSDP01)
- Project: Securing Data-Intensive Systems (DLMDMEDSPS01)

Module Exam Type

Module Exam	Split Exam
	Cyber Security and Data Protection • Study Format "Distance Learning": Oral Assignment • Study Format "myStudies": Oral Assignment Project: Securing Data-Intensive Systems • Study Format "Distance Learning": Oral Project Report

Module Contents

Project: Securing Data-Intensive Systems

Data-intensive systems are a technological building block supporting big data and data science applications. Given their degree of specialization, data-intensive systems pose special security and data protection challenges to practitioners. The course aims to apply the cyber-security and data protection foundations commonly associated to data-intensive systems.

Cyber Security and Data Protection

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

Learning Outcomes

Project: Securing Data-Intensive Systems

On successful completion, students will be able to

- elicit cyber-security and data protection requirements for the data-intensive system under consideration, and model the relevant threats.
- identify and apply relevant standards and regulations, in the areas of cyber-security and data protection, to a data-intensive system.
- design a security architecture taking on the computationally intensive tasks of a target big data system in the selected application field.
- develop criteria to evaluate and select the techniques fulfilling the elicited cyber-security and data protection requirements associated to data-intensive systems in at least one specific application field.
- develop a cyber-security concept covering the whole life-cycle of the data-intensive system, from threat modelling to data disposal.
- implement and monitor measures for data security and protection and to report their cyber-security reference implementation for at least one real-world data-intensive system.

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 Programs in the IT & Technology field

Cyber Security and Data Protection

Course Code: DLMCSITSDP01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 Endpoint Security
   - 4.3 Cyber Security in Networks
   - 4.4 Developing Secure IT Systems

5. Cyber Security Management
   - 5.1 Security Policy
   - 5.2 Security and Risk Analysis
   - 5.3 The ISO/IEC 27K 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 Elliptic-Curve Cryptography
   - 6.4 Hash Functions
   - 6.5 Secure Key Exchange

7. Cryptographic Applications
   - 7.1 Digital Signatures
   - 7.2 Secure Internet Protocols
   - 7.3 Blockchain
   - 7.4 Electronic Money

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 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
- ☑ Audio

Exam Preparation
- ☑ Online Tests
- ☑ Guideline

Study Format myStudies

Study Format	Course Type
myStudies	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
- ☑ Audio

Exam Preparation
- ☑ Online Tests
- ☑ Guideline

Project: Securing Data-Intensive Systems

Course Code: DLMDMEDSPS01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	Admission Requirements
MA	English		5	DLMCSITSDP01

Course Description

Data-intensive systems relate to a particular set of computing applications which process large volumes of data (typically terabytes or petabytes in size), which are referred to as “big data” and are typically leveraged in data science applications. The underlying computational paradigms associated to data-intensive systems (e.g., Cloud Computing, Internet of Things or Apache Spark) bring their own cyber-security and data protection requirements and challenges. In this project, students will have the opportunity to apply cyber-security and data protection best-practices to a real-world data-intensive system including but not limited to:

Course Outcomes

On successful completion, students will be able to

- elicit cyber-security and data protection requirements for the data-intensive system under consideration, and model the relevant threats.
- identify and apply relevant standards and regulations, in the areas of cyber-security and data protection, to a data-intensive system.
- design a security architecture taking on the computationally intensive tasks of a target big data system in the selected application field.
- develop criteria to evaluate and select the techniques fulfilling the elicited cyber-security and data protection requirements associated to data-intensive systems in at least one specific application field.
- develop a cyber-security concept covering the whole life-cycle of the data-intensive system, from threat modelling to data disposal.
- implement and monitor measures for data security and protection and to report their cyber-security reference implementation for at least one real-world data-intensive system.

Contents

- Given a real-world application scenario involving a data-intensive system (e.g., an IoT system with cloud-based storage, streaming analysis, and reporting capabilities), the students will develop a security concept encompassing its whole life-cycle. Starting with a focused threat modelling (identifying common risks associated to the usage of big data) and following with the elicitation of cyber-security and data protection measures, the students will propose a framework for securing the chosen data-intensive system. Furthermore, the proposed

cyber-security and data protection framework (comprising processes and tools) should also document a reference implementation for at least one of the subsystems comprising the data-intensive system.

Literature

Compulsory Reading

Further Reading

- Anderson, R. (2020): Security Engineering. A Guide to Building Dependable Distributed Systems. 3rd ed., John Wiley & Sons, United States of America.
- Chen, P. et al. (2014): Data-intensive applications, challenges, techniques and technologies. In: ScienceDirect Journal of Information Sciences, vol. 275, p. 314-347.
- Fernandez E. (2011): Security in Data Intensive Computing Systems. In: Handbook of Data Intensive Computing, p. 447-466.
- Jones, B. et al. (2019): HNSciCloud. A Hybrid Cloud for Science. In: Proceedings of the CHEP 2018 conference, volume 214, p. 1-8.
- Kehuan, Z. et al. (2011): Sedic. Privacy-aware data intensive computing on hybrid clouds. In: Proceedings of the 18th ACM conference on Computer and communications security, CCS '11, p. 515–526.
- Choo, R. et al. (2020): Handbook of Big Data Privacy. Springer-Verlag, United States of America.
- Kleppmann, M. (2017): Designing Data-Intensive Applications. The Big Ideas Behind Reliable, Scalable, and Maintainable Systems. O'Reilly Media Inc., United States of America.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Oral Project Report

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

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

Data Scientist

Module Code: DLMDMEDS-01

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMBDSA01-01	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. Gissel Velarde (Data Science) / Prof. Dr. Neil Arvin Bretana (Project: Applied Data Science)

Information about the Module Coordinator without guarantee

Contributing Courses to Module

- Data Science (DLMBDSA01-01)
- Project: Applied Data Science (DLMDMEDS01)

Module Exam Type

Module Exam	Split Exam
	Data Science • Study Format "Distance Learning": Exam, 90 Minutes • Study Format "myStudies": Exam, 90 Minutes Project: Applied Data Science • Study Format "Distance Learning": Oral Project Report

Module Contents

Data Science

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

Project: Applied Data Science

In the project students learn to independently organize and practically conduct all steps of a Data Science project from scratch to a production-ready model.

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.

Project: Applied Data Science

On successful completion, students will be able to

- assess and choose suitable techniques for data preprocessing and modeling with respect to a specific use case and available data.
- apply concepts and techniques in data science to real life use cases.
- independently organize a Data Science project.

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

Data Science

Course Code: DLMBDSA01-01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 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
- ☑ Course Feed
- ☑ Intensive Live Sessions/Learning Sprint
- ☑ Recorded Live Sessions

Learning Material
- ☑ Course Book
- ☑ Video

Exam Preparation
- ☑ Practice Exam
- ☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	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		

Project: Applied Data Science

Course Code: DLMDMEDS01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	Admission Requirements
MA	English		5	DLMBDSA01-01

Course Description

Students train their skills in assessing suitable Data Science techniques and frameworks for a specific real-life use case. By doing so, students consider the available data, explore the data in terms of its statical metrics and missing values and conduct necessary preprocessing steps. Students define suitable model KPIs, perform all necessary steps to build a base line model which is then improved by informed decisions about alternative modeling algorithms, feature engineering and hyperparameter tuning. In this project, students train their practical skills as well as their critical judgment with respect to suitable Data Science techniques for, ultimately, creating added value for organizations and businesses.

Course Outcomes

On successful completion, students will be able to

- assess and choose suitable techniques for data preprocessing and modeling with respect to a specific use case and available data.
- apply concepts and techniques in data science to real life use cases.
- independently organize a Data Science project.

Contents

- In this project, students acquaint themselves with the practical application of Data Science frameworks and techniques in real-life projects. Students are presented with a number of realistic use cases from which they choose one to be solved with Data Science techniques. The students independently choose suitable techniques and conduct the Data Science project in a problem-oriented manner.

Literature

Compulsory Reading

Further Reading

- Géron, A. (2017): Hands-on Machine Learning with Scikit-Learn and TensorFlow. Concepts, tools, and techniques to build intelligent systems. 1st Edition. O'Reilly, Sebastopol, CA.
- Grus, J. (2019): Data Science from Scratch. 2nd Edition. O'Reilly, Sebastopol, CA.
- McKinney, W. (2017): Python for Data Analysis. Data wrangling with Pandas, NumPy, and IPython. 2nd Edition. O'Reilly, Sebastopol, CA.

- VanderPlas, J. (2016): Python Data Science Handbook. Essential tools for working with data. 1st Edition. O'Reilly, Sebastopol, CA.

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

Information about the examination	
Examination Admission Requirements	**Online Tests:** no
Type of Exam	Oral Project Report

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

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

Business Analyst

Module Code: DLMDSEBA

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMDSEBA01	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) / Prof. Dr. Silke Vaas (Project: Business Intelligence)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Business Intelligence (DLMDSEBA01) ▪ Project: Business Intelligence (DLMDSEBA02)

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

Module Contents

Business Intelligence

- 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

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

Course Code: DLMDSEBA01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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	

Study Format myStudies

Study Format	Course Type
myStudies	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		

Project: Business Intelligence

Course Code: DLMDSEBA02

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

Study Format myStudies

Study Format	Course Type
myStudies	Project

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

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

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

Technical Project Lead

Module Code: DLMDSETPL

Module Type	Admission Requirements	Study Level	ECTS Credits	Student Workload
see curriculum	DLMBITPAM01	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. Carsten Skerra (IT Project Management) / Prof. Dr. Dorian Mora (Project: Technical Project Planning)
Information about the Module Coordinator without guarantee

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 • Study Format "myStudies": Exam, 90 Minutes Project: Technical Project Planning • Study Format "Distance Learning": Portfolio • Study Format "myStudies": Portfolio

Module Contents

IT Project Management

- Organizing the work
- Cost estimation and controlling
- The human factor
- Organizing small and medium projects
- Organizing 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	ECTS Credits	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
☑ Course Feed
☑ Intensive Live Sessions/Learning Sprint
☑ Recorded Live Sessions

Learning Material
☑ Course Book
☑ Video

Exam Preparation
☑ Practice Exam
☑ Online Tests

Study Format myStudies

Study Format	Course Type
myStudies	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		

Project: Technical Project Planning

Course Code: DLMDSETPL01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 ☑ Course Feed ☑ Intensive Live Sessions/Learning Sprint ☑ Recorded Live Sessions	**Exam Preparation** ☑ Guideline

Study Format myStudies

Study Format	Course Type
myStudies	Project

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

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

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

Process Management and Operational Application Systems

Module Code: DLMWIWPBA_E

Module Type	Admission Requirements	Study Level	ECTS Credits	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
Uma Santhosh Tumpala (Process Management) / Prof. Dr. Maik Drozdzynski (Operational Application Systems)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Process Management (DLMWIWPBA01_E) ▪ Operational Application Systems (DLMWIWPBA02_E)

Module Exam Type	
Module Exam	**Split Exam** Process Management • Study Format "Distance Learning": Exam, 90 Minutes Operational Application Systems • Study Format "Distance Learning": Written Assessment: Case Study

Module Contents

Process Management

- Terms and Motivation for Process Management
- Strategic Process Management
- Modeling of Business Processes
- Process Controlling
- Process Roll-Out
- Process Optimization

Operational Application Systems

- Categories of Operational Application Systems
- Business Process Management Systems
- Enterprise Resource Planning
- Supply Chain Management
- Customer Relationship Management
- Management Information Systems

Learning Outcomes

Process Management

On successful completion, students will be able to

- describe motivation of process management, delineate typical processes of design phases, and identify risks of process change.
- document business processes in a structured manner.
- describe the motivation and use of reference processes and name at least one typical reference process.
- describe and exemplify required activities in the reengineering of processes.
- describe phases of a process roll-out, analyze effects of process changes and identify risks.

Operational Application Systems

On successful completion, students will be able to

- describe and differentiate categories of business application systems.
- describe and differentiate typical tasks and functions of systems for business process management, workflow management and document management.
- describe the motivation and objectives of ERP systems and evaluate how they
- support the planning and control of operational and strategic resources.
- state and delineate objectives, functions, and an example scenario for supply chain management systems.
- describe objectives, functions, and an example scenario for customer relationship management systems.
- describe and differentiate the use and information structure of analytical information systems and their applications for management information.
- analyze and evaluate for given scenarios which business functions can be usefully deployed by which types of operational application systems and to describe the knowledge gained.

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 Programs in the IT & Technology field

Process Management

Course Code: DLMWIWPBA01_E

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

Course Description

Well-defined business processes are a central basis for the control and management of medium-sized and large organizations. They contain binding rules and agreements documenting the interaction of all organizational units and persons involved. In this course, practical documentation methods for process modeling and the use of reference processes are presented. In addition a discussion of phases and activities for reengineering processes is given which can then be used to redesign existing corporate processes. Subsequently, the course informs about organizational change and how it can be carried out with a process roll-out and what has to be considered in the process. Finally, the motivation, elements and results of strategic process management are presented and their relationships with corporate organization are explained.

Course Outcomes

On successful completion, students will be able to

- describe motivation of process management, delineate typical processes of design phases, and identify risks of process change.
- document business processes in a structured manner.
- describe the motivation and use of reference processes and name at least one typical reference process.
- describe and exemplify required activities in the reengineering of processes.
- describe phases of a process roll-out, analyze effects of process changes and identify risks.

Contents

1. Terms and Motivation for Process Management
   - 1.1 Terms: Process, Process Management
   - 1.2 Motivation for Process Management
   - 1.3 Risks and Challenges of Changing Processes in Organizations
   - 1.4 Phases of Process Design
   - 1.5 From Process to Workflow
2. Strategic Process Management
   - 2.1 Organizational Forms and Their Development
   - 2.2 Derivation of Enterprise Process Models
   - 2.3 Design and Structuring of Enterprise Process Models

2.4 Process Landscape and Process Maps
2.5 Reference Processes (ITIL, CMM as an Example)

3. Modeling of Business Processes
3.1 Actual and Target Modeling
3.2 Business Process and Notation (BPMN)
3.3 Extended Event Driven Process Chains (eEPC)

4. Process Controlling
4.1 The PDCA Approach and CIP
4.2 Process Controlling, KPIs, Metrics, Dimensions
4.3 Process Mining

5. Process Roll-Out
5.1 Phases of a Process Roll-Out
5.2 5.2 Simulation of Processes

6. Process Optimization
6.1 State-Analysis and Process Evaluation
6.2 Process Optimization
6.3 Analysis of the Effects of Process Changes
6.4 Change Management

Literature

Compulsory Reading

Further Reading

- Becker, J./Kugeler, M./Rosemann, M. (2011): Process Management. A Guide for the Design of Business Processes. 2nd Edition. Springer, Berlin/Heidelberg.
- Damij, N., Damij, T. (2014): Process Management. A Multi-disciplinary Guide to Theory, Modeling, and Methodology. Springer, Berlin/Heidelberg.
- Davis, R. (2008): ARIS Design Platform: Getting Started with BPM. Springer, London.
- Freund, J./Rücker, B. (2019): Real-Life BPMN. Includes an introduction to DMN. 4th Edition. Independently published.
- Hanschke, I. (2010): Strategic IT Management: A Toolkit for Enterprise Architecture Management. Springer, Berlin/Heidelberg.
- Process Maps (2019): IT Process Wiki - the ITIL®-Wiki. This Wiki is about the IT Infrastructure Library ITIL® (ITIL 4, ITIL V3 & V2) and IT Service Management (ITSM). (URL: https://wiki.en.it-processmaps.com/index.php/Main_Page [last access: 2021-02-16]).

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
	☑ Audio	

Operational Application Systems

Course Code: DLMWIWPBA02_E

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

Course Description

Almost every company uses operational application systems to perform or support business processes. In addition, many management decisions are made on the basis of data which is provided and evaluated by business application systems. This course first describes the categories of operational application systems and the business units in which they are used. Then, typical tasks and functions of systems for business process management, workflow management and document management are described.
In addition, tasks, functions and example scenarios for enterprise resource planning, supply chain management and customer relationship management systems are presented. Finally, analytical information systems and their applications as management information systems are described.

Course Outcomes

On successful completion, students will be able to

- describe and differentiate categories of business application systems.
- describe and differentiate typical tasks and functions of systems for business process management, workflow management and document management.
- describe the motivation and objectives of ERP systems and evaluate how they
- support the planning and control of operational and strategic resources.
- state and delineate objectives, functions, and an example scenario for supply chain management systems.
- describe objectives, functions, and an example scenario for customer relationship management systems.
- describe and differentiate the use and information structure of analytical information systems and their applications for management information.
- analyze and evaluate for given scenarios which business functions can be usefully deployed by which types of operational application systems and to describe the knowledge gained.

Contents

1. Categories of Operational Application Systems
   - 1.1 Terms, Objectives and Delimitation of Operational Application Systems
   - 1.2 Horizontal and Vertical Integration
   - 1.3 Example Scenario for the Use of Operational Application Systems
2. Systems for Handling Business Processes

2.1 Business Process Management Systems
2.2 Workflow Management Systems
2.3 Document Management Systems

3. Enterprise Resource Planning
   3.1 Motivation and Goals of Enterprise Resource Planning Systems
   3.2 Planning and Control of Operational Resources
   3.3 Planning and Control of Strategic Resources

4. Supply Chain Management
   4.1 Motivation and Objectives of Supply Chain Management Systems
   4.2 General Principles and Challenges in SCM
   4.3 Functions of SCM Systems
   4.4 Example Scenario for the Use of SCM Systems

5. Customer Relationship Management
   5.1 Motivation and Goals of Systems to CRM
   5.2 General Tasks of CRM
   5.3 Example Scenario for the Use of CRM Systems

6. Management Information Systems
   6.1 Analytical Information Systems and their Applications
   6.2 Information Structure from a Management Perspective
   6.3 Example Scenario for the Use of Management Information Systems

Literature

Compulsory Reading

Further Reading

- Bocij, P. (2018): Business Information Systems: Technology, Development and Management for the Modern Business. 6th Edition. Pearson.
- Kurbel, K. (2013): Enterprise Resource Planning and Supply Chain Management: Functions, Business Processes and Software for Manufacturing Companies (Progress in IS). Springer, London.
- Sharda, R. (2017). Business Intelligence, Analytics and Data Science: A Managerial Perspective. 4th Edition. Pearson.
- Vom Brocke, J., Simons, A. (2016): Enterprise Content Management in Information Systems Research: Foundations, Methods and Cases (Progress in IS). Springer, Heidelberg, New York.

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
	☑ Audio	

AI and Mastering AI Prompting

Module Code: DLMEAIMAIP-01

Module Type	Admission Requirements	Study Level	ECTS Credits	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. Claudia Heß (Artificial Intelligence) / Prof. Dr. Christian Kroll (Project: AI Excellence with Creative Prompting Techniques)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Artificial Intelligence (DLMAIAI01-01) ▪ Project: AI Excellence with Creative Prompting Techniques (DLMPAIECPT01)

Module Exam Type	
Module Exam	**Split Exam** Artificial Intelligence • Study Format "Distance Learning": Exam, 90 Minutes Project: AI Excellence with Creative Prompting Techniques • Study Format "Distance Learning": Written Assessment: Project Report • Study Format "myStudies": Written Assessment: Project Report

Module Contents

Artificial Intelligence

- History of AI
- AI Application Areas
- Expert Systems
- Neuroscience
- Modern AI Systems

Project: AI Excellence with Creative Prompting Techniques

In this module, students delve into the world of generative AI applications, creating AI-generated content such as text, images, and videos. They learn to design, analyze, and evaluate different prompting techniques in these systems and apply them within their respective fields of study.

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.

Project: AI Excellence with Creative Prompting Techniques

On successful completion, students will be able to

- comprehend and implement various prompting techniques in generative AI applications.
- analyze, assess, and combine different prompt techniques for various expected AI outputs.
- implement ethical considerations into the design and execution of various generative AI applications.
- design, implement, and refine effective prompts and their combinations for real-world scenarios through various hands-on exercises.
- showcase creative and innovative thinking and reasoning in the application of advanced prompting techniques to solve multidimensional problems in their specialized area of study.

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

Artificial Intelligence

Course Code: DLMAIAI01-01

Study Level	Language of Instruction and Examination	Contact Hours	ECTS Credits	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 current and future developments. In addition to these introductory topics, the course will explore the legal, social, and ethical responsibilities associated with the development and deployment of AI. The course will introduce principles of knowledge representation, ranging from the development and use of expert systems in early AI systems to knowledge graphs and semantic web technologies. In order to understand cognitive processes, the course will give a brief overview of the biological brain and (human) cognitive processes and then discuss how insights from human cognition inform the design and function of AI systems. Particular focus will be given to Artificial Neural Networks. Moreover, core technologies that drive modern AI applications will be introduced. Key areas of focus will include machine learning for data-driven improvement, natural language processing for understanding and generating human language, and computer vision for interpreting and making decisions from visual information. The course will give an overview of a wide range of AI use cases, ranging from creative content creation with Generative AI, to autonomous systems and robotics, to the role of AI in cybersecurity. The use cases will highlight the potential of AI across application areas and industries, such as autonomous driving, medicine, finance, retail, and manufacturing. For these use cases, the specific challenges related to the responsible use of AI will be discussed.

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 and Future of AI
   - 1.1 Historical Developments
   - 1.2 AI Winters
   - 1.3 Notable Advances in Artificial Intelligence

1.4 Legal, Social, and Ethical Responsibilities in AI Development and Deployment

2. Knowledge Representation
   - 2.1 Overview of Expert Systems
   - 2.2 Introduction to Logic and Prolog
   - 2.3 Knowledge Graphs

3. Bridging Biology and Technology: Neuroscience, Cognition, and Neural Networks
   - 3.1 Neuroscience and the Human Brain
   - 3.2 Cognitive Science
   - 3.3 The Relationship Between Neuroscience, Cognitive Science, and Artificial Intelligence
   - 3.4 Artificial Neural Networks

4. Core Technologies of Artificial Intelligence
   - 4.1 Machine Learning
   - 4.2 Natural Language Processing (NLP)
   - 4.3 Computer Vision

5. Applications of Artificial Intelligence
   - 5.1 Applications of Computer Vision
   - 5.2 Natural Language Processing Use Cases
   - 5.3 Creative Content Creation with Generative AI
   - 5.4 Autonomous Systems & Robotics
   - 5.5 Predictive Analytics
   - 5.6 AI in Cybersecurity

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 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		

Project: AI Excellence with Creative Prompting Techniques

Course Code: DLMPAIECPT01

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

Course Description

In this course, students explore the exciting world of prompting in various generative AI applications. They involve themselves in hands-on exercises that combine various prompting techniques to create new AI-generated content, including text, images, and videos. Through these exercises, students learn how to effectively use, analyze, combine, and assess these systems within their specialized fields of study.

Course Outcomes

On successful completion, students will be able to

- comprehend and implement various prompting techniques in generative AI applications.
- analyze, assess, and combine different prompt techniques for various expected AI outputs.
- implement ethical considerations into the design and execution of various generative AI applications.
- design, implement, and refine effective prompts and their combinations for real-world scenarios through various hands-on exercises.
- showcase creative and innovative thinking and reasoning in the application of advanced prompting techniques to solve multidimensional problems in their specialized area of study.

Contents

- In this course, students engage in a practical application of a generative AI use case by choosing from the options provided in the extensive supplementary guide. The course presents practical examples as study materials and exercises with both individual and combined prompting techniques for open-source text, image, and video generation use cases. The exercises are crafted to inspire and lead students in executing their distinct generative AI use case work and provide guidance on describing the use case and selecting a mixture of prompting techniques. Additionally, students are led to critically evaluate the design, implementation, and the outcomes from both technical and ethical perspectives.

Literature

Compulsory Reading

Further Reading

- Dang, H., Mecke, L., Lehmann, F., Goller, S., & Buschek, D. (2022). How to prompt? Opportunities and challenges of zero- and few-shot learning for human-AI interaction in creative applications of generative models. arXiv. https://arxiv.org/pdf/2209.01390.pdf
- Epstein, Z., Hertzmann, A., Herman, L., Mahari, R., Frank, M. R., Groh, M., Schroeder, H., Smith, A., Akten, M., Fjeld, J., Farid, H., Leach, N., Pentland, A. S., & Russakovsky, O. (2023). Art and the science of generative AI: A deeper dive. arXiv. https://arxiv.org/pdf/2306.04141.pdf
- Gozalo-Brizuela, R., & Garrido-Merchán, E. C. (2023). A survey of generative AI applications. arXiv. https://arxiv.org/pdf/2306.02781.pdf
- Wei, J., Wang, X., Schuurmans, D., Bosma, M. Ichter, B., Xia, F., Chi, E. H., Le., Q. V., & Zhou, D. (2023). Chain-of-though prompting elicit reasoning in large language models. arXiv. https://arxiv.org/pdf/2201.11903.pdf

Study Format Distance Learning

Study Format	Course Type
Distance Learning	Project

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

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	☑ Video	☑ Guideline

Study Format myStudies

Study Format	Course Type
myStudies	Project

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

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

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

4. Semester

Master Thesis

Module Code: MMTHE

Module Type	Admission Requirements	Study Level	ECTS Credits	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)
Information about the Module Coordinator without guarantee

Contributing Courses to Module
▪ Master Thesis (MMTHE01) ▪ Colloquium (MMTHE02)

Module Exam Type	
Module Exam	**Split Exam** Master Thesis • Study Format "Distance Learning": Master Thesis • Study Format "myStudies": Master Thesis Colloquium • Study Format "Distance Learning": Colloquium • Study Format "myStudies": Colloquium

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	ECTS Credits	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

Study Format myStudies

Study Format	Course Type
myStudies	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	ECTS Credits	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

Study Format myStudies

Study Format	Course Type
myStudies	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