

# MODULE HANDBOOK

**Master of Science**

Business Intelligence (FS-OI-MABUI-60)

60 CP

Distance Learning

Classification: Non-consecutive

# Contents

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## 1. Semester

### **Module DLMDSEBA1: Business Intelligence I**

Module Description .....	6
Course DLMDSEBA01: Business Intelligence I .....	8

### **Module DLMBIRND: Relational and NoSQL Databases**

Module Description .....	12
Course DLMBIRND01: Relational and NoSQL Databases .....	14

### **Module DLMDMDQL: Data Query Languages**

Module Description .....	18
Course DLMDMDQL01: Data Query Languages .....	20

### **Module DLMDSEBA2: Project: Business Intelligence**

Module Description .....	23
Course DLMDSEBA02: Project: Business Intelligence .....	25

### **Module DLMBIDWAT: Data Warehousing Architecture Types**

Module Description .....	28
Course DLMBIDWAT01: Data Warehousing Architecture Types .....	30

### **Module DLMBISDWAM: Seminar: Data Warehouse Approaches and Methodologies**

Module Description .....	34
Course DLMBISDWAM01: Seminar: Data Warehouse Approaches and Methodologies .....	36

---

## 2. Semester

### **Module DLMARM: Advanced Research Methods**

Module Description .....	40
Course DLMARM01: Advanced Research Methods .....	42

### **Module DLMBIEADMR: Applied Data Modeling and Reporting**

Module Description .....	47
Course DLMBIDMR01: Data Modeling and Reporting .....	50
Course DLMBIPDMR01: Project: Data Modeling and Reporting .....	54

### **Module DLMBIESDPDWS: Storage and Data Provisioning in Data Warehouse Systems**

Module Description .....	57
--------------------------	----

Course DLMBIETLT01: Extract, Transform and Load Technologies . . . . .	59
Course DLMBIESDPDWS01: Project: Extract, Transform and Load Technologies . . . . .	63
<b>Module DLMBIEBDE: Big Data Engineering</b>	
Module Description . . . . .	65
Course DLMDSBDT01: Big Data Technologies . . . . .	67
Course DLMBIEBDE01: Project: Big Data Technologies . . . . .	71
<b>Module DLMEAIMAIP: AI and Mastering AI Prompting</b>	
Module Description . . . . .	73
Course DLMAIAI01: Artificial Intelligence . . . . .	75
Course DLMPAIECPT01: Project: AI Excellence with Creative Prompting Techniques . . . . .	79
<b>Module DLMMTHES: Master Thesis</b>	
Module Description . . . . .	82
Course DLMMTHES01: Master Thesis . . . . .	84
Course DLMMTHES02: Colloquium . . . . .	88

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# 1. Semester

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## Business Intelligence I

Module Code: DLMDSEBA1

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> none	<b>Study Level</b> MA	<b>CP</b> 5	<b>Student Workload</b> 150 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

Prof. Dr. Silke Vaas (Business Intelligence I)

### Contributing Courses to Module

- Business Intelligence I (DLMDSEBA01)

### Module Exam Type

#### Module Exam

Study Format: Distance Learning  
Written Assessment: Case Study  
Study Format: myStudies  
Written Assessment: Case Study

#### Split Exam

### Weight of Module

see curriculum

### Module Contents

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

**Learning Outcomes****Business Intelligence I**

On successful completion, students will be able to

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

**Links to other Modules within the Study Program**

This module is similar to other modules in the fields of Computer Science & Software Development

**Links to other Study Programs of the University**

All Master Programs in the IT & Technology fields

# Business Intelligence I

Course Code: DLMDSEBA01

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

## Course Description

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

## Course Outcomes

On successful completion, students will be able to

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

## Contents

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



- 4.1 Data Modeling
- 4.2 OLAP-Cubes
- 4.3 Physical Storage Concepts
- 4.4 Star-Schema and Snowflake-Schema
- 4.5 Historization
  
5. Analytical Systems
  - 5.1 Freeform Data Analysis and OLAP
  - 5.2 Reporting Systems
  - 5.3 Model-Based Analytical Systems
  - 5.4 Concept-Oriented Systems
  
6. Distribution and Access
  - 6.1 Information Distribution
  - 6.2 Information Access
  
7. Current and Future Business Intelligence Application Areas
  - 7.1 Mobile Business Intelligence
  - 7.2 Predictive and Prescriptive Analytics
  - 7.3 Artificial Intelligence
  - 7.4 Agile Business Intelligence

## Literature

### Compulsory Reading

#### Further Reading

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

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Written Assessment: Case Study

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

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Online Tests <input checked="" type="checkbox"/> Guideline

**Study Format myStudies**

<b>Study Format</b> myStudies	<b>Course Type</b>
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Written Assessment: Case Study

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

<b>Instructional Methods</b>

## Relational and NoSQL Databases

Module Code: DLMBIRND

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> None	<b>Study Level</b> MA	<b>CP</b> 5	<b>Student Workload</b> 150 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

Prof. Dr. Silke Vaas (Relational and NoSQL Databases)

### Contributing Courses to Module

- Relational and NoSQL Databases (DLMBIRND01)

### Module Exam Type

#### Module Exam

Study Format: Distance Learning  
Written Assessment: Written Assignment

#### Split Exam

### Weight of Module

see curriculum

### Module Contents

- Database Concepts
- Database Physiology
- Selected Relational Databases in Practice
- NoSQL Concepts
- Selected NoSQL Databases in Practice

**Learning Outcomes****Relational and NoSQL Databases**

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.
- differentiate between Relational Databases and NoSQL Databases in terms of usage and underlying principles.
- explain the concepts of key-value-oriented, document-oriented, column-oriented and graph-oriented Databases, use common databases of these kinds in data-intensive projects and assess their suitability for specific use cases.
- differentiate between common relational and NoSQL databases and conduct basic tasks in these databases.

**Links to other Modules within the Study Program**

This module is similar to other modules in the fields of Data Science & Artificial Intelligence

**Links to other Study Programs of the University**

All Master Programs in the IT & Technology fields

## Relational and NoSQL Databases

Course Code: DLMBIRND01

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

### Course Description

Storing and managing data in databases is at its very heart of all data-related projects. In this course, students learn concepts and technologies for the management and usage of relational and NoSQL 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 they 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 volume of data, students learn how distributing databases across clusters of machines can increase the scalability and reliability. 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. 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. Students will 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 are enabled to differentiate between common relational and NoSQL 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.
- differentiate between Relational Databases and NoSQL Databases in terms of usage and underlying principles.
- explain the concepts of key-value-oriented, document-oriented, column-oriented and graph-oriented Databases, use common databases of these kinds in data-intensive projects and assess their suitability for specific use cases.
- differentiate between common relational and NoSQL databases and conduct basic tasks in these databases.

**Contents**

1. Database Concepts
  - 1.1 The ACID Principle for Databases
  - 1.2 OLAP and OLTP
  - 1.3 Data Handling Ethics
  - 1.4 Cardinality and its Limits
2. Database Physiology
  - 2.1 Database Components
  - 2.2 Database Categorization
  - 2.3 Indexing
  - 2.4 Vertical Fragmentation and Sharding
  - 2.5 Connecting to Databases
3. Selected Relational Databases in Practice
  - 3.1 Introduction to SQL
  - 3.2 Data Schemas
  - 3.3 MySQL
  - 3.4 PostgreSQL
  - 3.5 SQL Server
  - 3.6 Snowflake
4. NoSQL Concepts
  - 4.1 Schemaless Data and the ACID Principle

- 4.2 Types of NoSQL Databases
- 4.3 Data Structure and Storage
- 5. Selected NoSQL Databases in Practice
  - 5.1 Redis
  - 5.2 MongoDB
  - 5.3 Cassandra
  - 5.4 HBase
  - 5.5 Neo4j

## Literature

### Compulsory Reading

#### Further Reading

- Petrov, A. (2019): Database Internals: A deep-dive into how distributed data systems work. 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
- Beaulieu, A. (2020): Learning SQL. 3rd Edition, O'Reilly, Sebastopol, CA.
- Kelly, A./McCreary, D. (2013): Making Sense of NoSQL. 1st Edition, O'Reilly, Sebastopol, CA.
- Sadalage, P. (2009): NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence. 1st Edition, Addison-Wesley Professional, Boston, MS
- Ploetz, A./Kandhare, D./Kadambi, S./Wu, X. (2018): Seven NoSQL Databases in a Week. 1st Edition, Packt Publishing, Birmingham, UK
- Harrison, G. (2016): Next Generation Databases: NoSQL, NewSQL, and Big Data. 1st Edition, Apress, New York, NY
- 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
- Nelson, J. (2016): Mastering Redis. 1st Edition, Packt Publishing, Birmingham, UK
- George, L. (2011): HBase: The Definitive Guide. 1st Edition, O'Reilly, Sebastopol, CA
- Hodler, A. (2019): Graph Algorithms: Practical Examples in Apache Spark and Neo4j. 1st Edition, O'Reilly, Sebastopol, CA



**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Written Assessment: Written Assignment

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Online Tests <input checked="" type="checkbox"/> Guideline

## Data Query Languages

Module Code: DLMDMDQL

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> none	<b>Study Level</b> MA	<b>CP</b> 5	<b>Student Workload</b> 150 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

Dr. Thomas Kopsch (Data Query Languages)

### Contributing Courses to Module

- Data Query Languages (DLMDMDQL01)

### Module Exam Type

#### Module Exam

Study Format: Distance Learning  
Oral Assignment

#### Split Exam

### Weight of Module

see curriculum

### Module Contents

- 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**

This module is similar to other modules in the field of Data Science & Artificial Intelligence

**Links to other Study Programs of the University**

All Master Programs in the IT & Technology field

## Data Query Languages

Course Code: DLMDMDQL01

Study Level	Language of Instruction and Examination	Contact Hours	CP	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**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Oral Assignment

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Online Tests <input checked="" type="checkbox"/> Guideline

## Project: Business Intelligence

Module Code: DLMDSEBA2

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> DLMDSEBA01	<b>Study Level</b> MA	<b>CP</b> 5	<b>Student Workload</b> 150 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

Prof. Dr. Silke Vaas (Project: Business Intelligence)

### Contributing Courses to Module

- Project: Business Intelligence (DLMDSEBA02)

### Module Exam Type

#### Module Exam

Study Format: Distance Learning

Portfolio

Study Format: myStudies

Portfolio

#### Split Exam

### Weight of Module

see curriculum

### Module Contents

Implementation of a business intelligence use case.

**Learning Outcomes****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**

This module is similar to other modules in the fields of Data Science & Artificial Intelligence

**Links to other Study Programs of the University**

All Master Programs in the IT & Technology fields



## Project: Business Intelligence

Course Code: DLMDSEBA02

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

### Course Description

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

### Course Outcomes

On successful completion, students will be able to

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

### Contents

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

### Literature

#### Compulsory Reading

#### Further Reading

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

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Project
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Portfolio

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline

**Study Format myStudies**

<b>Study Format</b> myStudies	<b>Course Type</b>
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Portfolio

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

<b>Instructional Methods</b>

## Data Warehousing Architecture Types

Module Code: DLMBIDWAT

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> DLMDSEBA01, DLMBIRND01	<b>Study Level</b> MA	<b>CP</b> 5	<b>Student Workload</b> 150 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

Prof. Dr. Silke Vaas (Data Warehousing Architecture Types)

### Contributing Courses to Module

- Data Warehousing Architecture Types (DLMBIDWAT01)

### Module Exam Type

#### Module Exam

Study Format: Distance Learning  
Exam, 90 Minutes

#### Split Exam

### Weight of Module

see curriculum

### Module Contents

- Traditional and Big Data Warehousing
- Data Warehouse Architecture (DWHA): Single-Layer, Two-Layer and Three-Layer Architectures
- Data Warehouse Components
- The Two Main Classification Models
- Representatives of these Models
- DWHA „Big Picture“ (Representatives in the Context of Structured and Unstructured Data, New Technologies and the Business Intelligence Process Components)

**Learning Outcomes****Data Warehousing Architecture Types**

On successful completion, students will be able to

- understand relevant types of data, as well as fundamentals of traditional and NoSQL Data Warehousing.
- explain frameworks to address big data challenges in particular of unstructured data.
- explain the two main DWHA classifications views and the inter-relations between them that observe DWHAs from different views.
- identify the main types of architecture belonging to the above classifications and view their characteristics.
- transfer knowledge of application- specific Data Warehouse methodology to implementations that are particularly relevant in practice.
- explain where the typical application scenarios differ in terms of data provision.

**Links to other Modules within the Study Program**

This module is similar to other modules in the fields of Data Science & Artificial Intelligence

**Links to other Study Programs of the University**

All Master Programs in the IT & Technology fields

## Data Warehousing Architecture Types

Course Code: DLMBIDWAT01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSEBA01, DLMBIRND01

### Course Description

Nowadays, Data Warehouses, DWHs for short, are faced with big data namely with structured and unstructured data. In order to address this challenges, DWHs are extended and merged with state-of-the art technology. In addition, a variety of practical applications has resulted in different architectures. The course covers techniques for the technical processing of data, explains the two main Data Warehousing Architecture (DWHA) classifications and introduces the main representatives of these two classes.

### Course Outcomes

On successful completion, students will be able to

- understand relevant types of data, as well as fundamentals of traditional and NoSQL Data Warehousing.
- explain frameworks to address big data challenges in particular of unstructured data.
- explain the two main DWHA classifications views and the inter-relations between them that observe DWHAs from different views.
- identify the main types of architecture belonging to the above classifications and view their characteristics.
- transfer knowledge of application- specific Data Warehouse methodology to implementations that are particularly relevant in practice.
- explain where the typical application scenarios differ in terms of data provision.

### Contents

1. Introduction
  - 1.1 Big data: Structured, Semi-Structured and Unstructured Data Types
  - 1.2 Unstructured Big Data Challenges
  - 1.3 Characteristics of Data Warehouses
  - 1.4 RDBMS-Based Data Warehousing
  - 1.5 NoSQL-Based Data Warehousing
2. Classification
  - 2.1 Layer-Based Classification
  - 2.2 Component-Based Classification

3. Data Warehouse Architecture
  - 3.1 Single-Layer Architecture
  - 3.2 Two-Layer Architecture
  - 3.3 Three-Layer Architecture
4. Data Warehouse Components
  - 4.1 Databases
  - 4.2 ETL-Process Components
  - 4.3 Data Marts
  - 4.4 Bus Architecture
5. Big Data Frameworks
  - 5.1 Hadoop
  - 5.2 Hive
  - 5.3 Data Lake
6. Data Warehouse Architecture (DWHA) Types
  - 6.1 Hub-and-Spoke DWHA
  - 6.2 Data Mart Bus DWHA
  - 6.3 Centralised DWHA
  - 6.4 Independent DWHA
  - 6.5 Federated DWHA
  - 6.6 Virtual DWHA
  - 6.7 Distributed DWHA
  - 6.8 Big DWHA
  - 6.9 Architecture Overview and Distribution
7. Application-Specific Data Warehouses (DWHs)
  - 7.1 Top-Down and Bottom-Up Approaches
  - 7.2 Real-Time DWHs
  - 7.3 Closed-Loop DWHs
  - 7.4 Active DWHs
  - 7.5 Practical Implementations

**Literature****Compulsory Reading****Further Reading**

- Ariyachandra, T./ Watson, H. J. (2008). Which data warehouse architecture is the best? In Communications of the ACM, 51(10), p.146. ACM.
- Ariyachandra, T. / Watson, H. (2010). Key organizational factors in data warehouse architecture selection. In Decision support systems. 2010 31;49(2):200-12.
- Devlin, B. / Cote, L. (1996). Data warehouse: from architecture to implementation. Addison-Wesley Longman Publishing Co., Inc.
- George, S. (2012). Inmon vs. kimball: Which approach is suitable for your data warehouse. Data warehous. In pp.1-12.
- Kimball, R. / Ross, M. (2013). The data warehouse toolkit: the complete guide to dimensional modeling, John Wiley & Sons.
- Pasupuleti, P / Purra, B. (2015). Data Lake Development with Big Data, Packt Publishing Ltd.
- Yang Q. / Ge M. / Helfert M. (2019) Analysis of Data Warehouse Architectures: Modeling and Classification, International Conference on Enterprise Information Systems (ICEIS)
- Senapati, R. / Kumar, D. A. (2014). A survey on data warehouse architecture. In International Journal of Innovative Research in Computer and Communication Engineering.
- Scheibe, K. / Nilakanta, S. (2008). Dimensional issues in agricultural data warehouse designs, In pp.263-278, Electronics in agriculture, 60(2).



**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Exam, 90 Minutes

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Practice Exam <input checked="" type="checkbox"/> Online Tests

## Seminar: Data Warehouse Approaches and Methodologies

Module Code: DLMBISDWAM

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> DLMDSEBA01, DLMBIDWAT01	<b>Study Level</b> MA	<b>CP</b> 5	<b>Student Workload</b> 150 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

Prof. Dr. Silke Vaas (Seminar: Data Warehouse Approaches and Methodologies)

### Contributing Courses to Module

- Seminar: Data Warehouse Approaches and Methodologies (DLMBISDWAM01)

### Module Exam Type

#### Module Exam

Study Format: Distance Learning  
Written Assessment: Research Essay

#### Split Exam

### Weight of Module

see curriculum

### Module Contents

In this course, students research, explore and present data warehouse approaches and methods.

**Learning Outcomes****Seminar: Data Warehouse Approaches and Methodologies**

On successful completion, students will be able to

- demonstrate the ability to conduct research, read critically, and evaluate sources.
- reflect on the exploration of data warehousing approaches and methods.
- evaluate data warehousing methods based on a common set of attributes.
- describe data warehousing methods including business requirements analysis, data design, architectural design, implementation and deployment.
- explain the major techniques of data warehousing and all related procedures.
- demonstrate the meaningful use of technical skills through documentation.
- explain which methods can be relevant in the context of data warehousing data protection.

**Links to other Modules within the Study Program**

This module is similar to other modules in the fields of Data Science & Artificial Intelligence

**Links to other Study Programs of the University**

All Master Programs in the IT & Technology fields

## Seminar: Data Warehouse Approaches and Methodologies

Course Code: DLMBISDWAM01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSEBA01, DLMBIDWAT01

### Course Description

The focus of this course is to explore and present data warehouse approaches and methods in a research project. In doing so, students will examine and reflect on data warehouse methods and their impact on project success.

### Course Outcomes

On successful completion, students will be able to

- demonstrate the ability to conduct research, read critically, and evaluate sources.
- reflect on the exploration of data warehousing approaches and methods.
- evaluate data warehousing methods based on a common set of attributes.
- describe data warehousing methods including business requirements analysis, data design, architectural design, implementation and deployment.
- explain the major techniques of data warehousing and all related procedures.
- demonstrate the meaningful use of technical skills through documentation.
- explain which methods can be relevant in the context of data warehousing data protection.

### Contents

- In this course, students conduct a research project by researching and documenting existing literature and known platforms and products on data warehouse approaches and methods.

**Literature****Compulsory Reading****Further Reading**

- Corr, Lawrence / Stagnitto, Jim. (2011): Agile Data Warehouse Design: Collaborative Dimensional Modeling, from Whiteboard to Star. DecisionOne Press.
- Jukic , Nenad / Vrbsky, Susan / Nestorov, Svetlozar. (2016): Database Systems: Introduction to Databases and Data Warehouses. Prospect Press.
- Lakshmanan , Valliappa / Tigani, Jordan. (2019): Google BigQuery: The Definitive Guide: Data Warehousing, Analytics, and Machine Learning at Scale. O'Reilly Media.
- Rainardi , Vincent. (2014): Building a Data Warehouse: With Examples in SQL Server. Apress.
- tutorialspoint (2021): Data Warehousing – Concepts. (URL: [https://www.tutorialspoint.com/dwh/dwh\\_data\\_warehousing.htm](https://www.tutorialspoint.com/dwh/dwh_data_warehousing.htm))

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Seminar
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Written Assessment: Research Essay

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

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline

## 2. Semester

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## Advanced Research Methods

Module Code: DLMARM

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> none	<b>Study Level</b> MA	<b>CP</b> 5	<b>Student Workload</b> 150 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

Prof. Dr. Tamara Wehrstein (Advanced Research Methods)

### Contributing Courses to Module

- Advanced Research Methods (DLMARM01)

### Module Exam Type

#### Module Exam

Study Format: Distance Learning  
Written Assessment: Written Assignment

Study Format: myStudies  
Written Assessment: Written Assignment

#### Split Exam

### Weight of Module

see curriculum

### Module Contents

- Social Science and Research Paradigms
- Case Study Research
- Specific Topics of Qualitative Research
- Advanced Issues of Qualitative Research Conceptualization and Data Analysis
- Underlying Assumptions of Quantitative Research: Concepts and Consequences
- Evaluation Research



**Learning Outcomes****Advanced Research Methods**

On successful completion, students will be able to

- understand and apply scientific methodologies in conducting empirical research.
- plan, design, and prepare research proposals.
- differentiate between different types of case studies, select and apply different data collection strategies.
- plan, conduct, and analyze case studies and surveys.
- scientifically analyze quantitative and qualitative data.
- conduct evaluation research to determine quality of research.

**Links to other Modules within the Study Program**

This module is similar to other modules in the field of Methods

**Links to other Study Programs of the University**

All Master Programmes in the Business & Management fields

## Advanced Research Methods

Course Code: DLMARM01

Study Level	Language of Instruction and Examination	Contact Hours	CP	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

- understand and apply scientific methodologies in conducting empirical research.
- plan, design, and prepare research proposals.
- differentiate between different types of case studies, select and apply different data collection strategies.
- plan, conduct, and analyze case studies and surveys.
- scientifically analyze quantitative and qualitative data.
- conduct evaluation research to determine quality of research.

### Contents

1. Theoretical Background: Social Science and Research Paradigms
  - 1.1 What is a Paradigm?
  - 1.2 Empiricism
  - 1.3 Critical Rationalism
  - 1.4 Epistemological Anarchism
  - 1.5 Structural Functionalism
  - 1.6 Symbolic Interactionism
  - 1.7 Ethnomethodology
2. Case Study Research

- 2.1 Types of Case Study Research
- 2.2 Maintaining Quality in Case Study Research
- 2.3 Case Study Design
- 2.4 Implementing Case Studies
- 2.5 Analyzing Case Studies
3. Specific Topics of Qualitative Research
  - 3.1 Idea Generation
  - 3.2 Critical Incident Technique
  - 3.3 Understanding Communication: Discourse Analysis
  - 3.4 Perceiving Perception: Interpretive Phenomenological Analysis
4. Advanced Issues of Qualitative Research Conceptualizing and Data Analysis
  - 4.1 Measurement Theory
  - 4.2 Index and Scale Construction
  - 4.3 Types of Scale Construction
  - 4.4 The Problem of Nonresponse and Missing Data
  - 4.5 Implications of IT for Research Strategies
5. Underlying Assumptions of Quantitative Research: Concepts and Consequences
  - 5.1 Classical Test Theory
  - 5.2 Probabilistic Test Theory
  - 5.3 Advanced Topics of Test Theory
6. Evaluation Research
  - 6.1 What is Evaluation Research?
  - 6.2 Types of Evaluation Research
  - 6.3 Meta-Analysis
  - 6.4 Meta-Evaluation

**Literature****Compulsory Reading****Further Reading**

- Babbie, E. R. (2021). The practice of social research (15th ed.). Cengage Learning. - 14th ed. (2016)
- Crossman, A. (2019) How to conduct an index for research. (URL: <https://www.thoughtco.com/index-for-research-3026543> [last accessed on 15.03.2023]).
- Eurostat (n.d.) Beginners: Statistical concept - Index and base year (URL: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Beginners:Statistical\\_concept\\_-\\_Index\\_and\\_base\\_year](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Beginners:Statistical_concept_-_Index_and_base_year) [last accessed on 15.03.2023]).
- 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**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Written Assessment: Written Assignment

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Online Tests <input checked="" type="checkbox"/> Guideline

**Study Format myStudies**

<b>Study Format</b> myStudies	<b>Course Type</b> Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Written Assessment: Written Assignment

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Online Tests <input checked="" type="checkbox"/> Guideline

## Applied Data Modeling and Reporting

Module Code: DLMBIEADMR

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> <ul style="list-style-type: none"> <li>▪ None</li> <li>▪ DLMDSEBA01, DLMBIDMR01</li> </ul>	<b>Study Level</b> MA	<b>CP</b> 10	<b>Student Workload</b> 300 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

Prof. Dr. Silke Vaas (Data Modeling and Reporting) / Prof. Dr. Peter Poensgen (Project: Data Modeling and Reporting)

### Contributing Courses to Module

- Data Modeling and Reporting (DLMBIDMR01)
- Project: Data Modeling and Reporting (DLMBIPDMR01)

### Module Exam Type

<b>Module Exam</b>	<b>Split Exam</b>  <u>Data Modeling and Reporting</u> <ul style="list-style-type: none"> <li>• Study Format "Distance Learning": Exam, 90 Minutes</li> </ul> <u>Project: Data Modeling and Reporting</u> <ul style="list-style-type: none"> <li>• Study Format "Distance Learning": Written Assessment: Project Report</li> </ul>
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### Weight of Module

see curriculum

**Module Contents****Data Modeling and Reporting**

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

**Project: Data Modeling and Reporting**

In this course, students will learn to apply the data modeling and reporting methods learned in the previous course to a hands-on project.

**Learning Outcomes****Data Modeling and Reporting**

On successful completion, students will be able to

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

**Project: Data Modeling and Reporting**

On successful completion, students will be able to

- implement a project with a focus on data modeling using SQL.
- practice and refine the knowledge they have learned about modeling data.
- demonstrate how to query, filter, sort, and report on data.
- customize output and evaluate results.
- show meaningful application of technical skills through documentation.
- introduce the major data modeling techniques and any associated procedures.
- consider the provision of a wide variety of data sources with regard to data protection in case studies.



**Links to other Modules within the Study Program**

This module is similar to other modules in the fields of Data Science & Artificial Intelligence

**Links to other Study Programs of the University**

All Master Programs in the IT & Technology fields

## Data Modeling and Reporting

Course Code: DLMBIDMR01

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

### Course Description

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

### Course Outcomes

On successful completion, students will be able to

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

### Contents

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

- 2.3 Model and Validate
- 2.4 Build and Deploy
- 2.5 Test, Release and Document
- 3. Data Model Types
  - 3.1 Hierarchical Model
  - 3.2 Relational Model
  - 3.3 Network Model
  - 3.4 Object-Oriented Model
  - 3.5 Entity-Relationship Model
- 4. Data Extraction Using SQL
  - 4.1 Basic Concepts
  - 4.2 Querying and Filtering
  - 4.3 Aggregate Functions
  - 4.4 Sorting and Grouping Results
  - 4.5 Querying Multiple Tables
- 5. NoSQL Data Extraction
  - 5.1 Motives and Characteristics
  - 5.2 Key-Value Stores
  - 5.3 Document Stores
  - 5.4 Column Family Stores
  - 5.5 Graph Databases
- 6. Data Reporting
  - 6.1 Reporting Tools
  - 6.2 Layout and Format
  - 6.3 Automated Data Reporting
  - 6.4 SQL Reporting
- 7. Online Transactional Processing
  - 7.1 Transactional Data
  - 7.2 Key Selection Criteria
  - 7.3 Capability Matrix
  - 7.4 Technology Choices
- 8. Online Analytical Processing
  - 8.1 OLAP Cubes Structure

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

### Literature

#### Compulsory Reading

#### Further Reading

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

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Exam, 90 Minutes

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed <input checked="" type="checkbox"/> Intensive Live Sessions/Learning Sprint	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Practice Exam <input checked="" type="checkbox"/> Online Tests

## Project: Data Modeling and Reporting

Course Code: DLMBIPDMR01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSEBA01, DLMBIDMR01

### Course Description

The focus of this course is to apply the previously acquired knowledge on data modeling, reporting to a practical project implementation and to reflect on the results. Students will carry out the project based on a given set of requirements and document the results.

### Course Outcomes

On successful completion, students will be able to

- implement a project with a focus on data modeling using SQL.
- practice and refine the knowledge they have learned about modeling data.
- demonstrate how to query, filter, sort, and report on data.
- customize output and evaluate results.
- show meaningful application of technical skills through documentation.
- introduce the major data modeling techniques and any associated procedures.
- consider the provision of a wide variety of data sources with regard to data protection in case studies.

### Contents

- In this course, students conduct and document a data modeling project, applying the topics covered in previous modules based on a given set of requirements. They use SQL to implement the designed model.

**Literature****Compulsory Reading****Further Reading**

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

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Project
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Written Assessment: Project Report

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

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline



# Storage and Data Provisioning in Data Warehouse Systems

Module Code: DLMBIESDPDWS

Module Type	Admission Requirements	Study Level	CP	Student Workload
see curriculum	<ul style="list-style-type: none"> <li>▪ DLMBIETLT01, DLMDSEBA01, DLMDMDQL01</li> <li>▪ DLMDSEBA01, DLMDMDQL01</li> </ul>	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 (Extract, Transform and Load Technologies) / Prof. Dr. Peter Poensgen (Project: Extract, Transform and Load Technologies)

## Contributing Courses to Module

- Extract, Transform and Load Technologies (DLMBIETLT01)
- Project: Extract, Transform and Load Technologies (DLMBIESDPDWS01)

## Module Exam Type

Module Exam	Split Exam
	<p><u>Extract, Transform and Load Technologies</u></p> <ul style="list-style-type: none"> <li>• Study Format "Distance Learning": Written Assessment: Case Study</li> </ul> <p><u>Project: Extract, Transform and Load Technologies</u></p> <ul style="list-style-type: none"> <li>• Study Format "Distance Learning": Written Assessment: Project Report</li> </ul>

**Weight of Module**

see curriculum

**Module Contents****Extract, Transform and Load Technologies**

- ETL-Process for SQL- and NoSQL Warehousing
- Main Features and Functions of ETL-Tools
- Practical Implementation Scenarios of ETL
- Common ETL Test Procedures

**Project: Extract, Transform and Load Technologies**

In this course, students learn to apply the Extract, Transform and Load (ETL) methods and technologies, they learned in previous module, in a practical project.

**Learning Outcomes****Extract, Transform and Load Technologies**

On successful completion, students will be able to

- illustrate and explain the general ETL process issues and its three essential steps.
- explain the main differences between SQL- and NoSQL-Warehousing.
- understand the ETL construction process for SQL- Data Warehousing and, in contrast, the main properties of NoSQL-Warehousing ETL framework.
- compare some ETL-Tools and their main features and functions.
- formulate and implement an ETL-testing use case.
- explain where to pay attention to data protection aspects within the ETL process.

**Project: Extract, Transform and Load Technologies**

On successful completion, students will be able to

- practice and deepen the learned ETL knowledge.
- implement methods for moving data from different sources into a data warehouse.
- design a common data repository and associated ETL process for a data warehouse.
- evaluate the results of the ETL process.
- demonstrate the effective use of technical skills through documentation.
- present the main techniques of ETL and all related procedures.

**Links to other Modules within the Study Program**

This module is similar to other modules in the field of Data Science & Artificial Intelligence

**Links to other Study Programs of the University**

All Master Programs in the IT & Technology field

## Extract, Transform and Load Technologies

Course Code: DLMBIETLT01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSEBA01, DLMDMDQL01

### Course Description

In order to merge and prepare data from several operational data sources, it is converted into management-relevant information via a process of targeted conversion. This is carried out using three steps (extract, transform, and load) which are collectively known as the ETL process. The modeling of the process depends, among other things, on the structure of the underlying data and can also have different structures depending on the requirements. Extensive tests are therefore an essential part of the overall concept.

### Course Outcomes

On successful completion, students will be able to

- illustrate and explain the general ETL process issues and its three essential steps.
- explain the main differences between SQL- and NoSQL-Warehousing.
- understand the ETL construction process for SQL- Data Warehousing and, in contrast, the main properties of NoSQL-Warehousing ETL framework.
- compare some ETL-Tools and their main features and functions.
- formulate and implement an ETL-testing use case.
- explain where to pay attention to data protection aspects within the ETL process.

### Contents

1. Introduction
  - 1.1 The Typical Real-Life ETL Cycle in the Data Warehouses
  - 1.2 Step 1: Data Extraction
  - 1.3 Step 2: Transformation
  - 1.4 Step 3: Loading
  - 1.5 SQL and NoSQL Warehousing
2. ETL-Process for SQL Data Warehousing
  - 2.1 Building Dimensions and Fact Tables
  - 2.2 Building Dimensions Referential Integrity
  - 2.3 Types of Data Sources
  - 2.4 Modeling the Extract Process
  - 2.5 Common Transformations

- 2.6 Loading Data
- 2.7 Metadata
- 3. ETL-Based Frameworks for NoSQL Warehousing
  - 3.1 Introduction: Types of NoSQL Warehouses and ETL-Process Types
  - 3.2 Data Extraction
  - 3.3 Transformation Rules
  - 3.4 Meta-Data Based Transactions
  - 3.5 Data Quality
  - 3.6 Loading Scenarios
  - 3.7 ETL vs. ELT
- 4. ETL-Tools
  - 4.1 Power BI Classification of ETL Tools
  - 4.2 MS Integration Services
- 5. Pactical Implementation Scenarios of ETL
  - 5.1 Example ETL Flow
  - 5.2 Package Control Flow
- 6. ETL-Testing
  - 6.1 Production Validation Testing ETL Testing Challenges
  - 6.2 Source-to-Target Count Testing ETL Testing Tools
  - 6.3 Data Integration Testing Types of ETL Testing

**Literature****Compulsory Reading****Further Reading**

- Berkani N. / Bellatreche L. (2017): A Variety-Sensitive ETL Processes, International Conference on Database and Expert Systems Applications, DEXA 2017: Database and Expert Systems Applications pp 201-216
- Dahaoui FZ., Demraoui L., Chbihi Louhdi M.R., Behja H. (2021) Toward Data Warehouse Modeling in the Context of Big Data. In: Saeed F., Al-Hadhrami T., Mohammed F., Mohammed E. (eds) Advances on Smart and Soft Computing. Advances in Intelligent Systems and Computing, vol 1188. Springer, Singapore.  
[https://doi.org/10.1007/978-981-15-6048-4\\_21](https://doi.org/10.1007/978-981-15-6048-4_21)
- Mallek H. / Ghozzi F. / Gargouri F. (2020): Towards Extract-Transform-Load Operations in a Big Data context, International Journal of Sociotechnology and Knowledge Development (IJSKD) 12(2).
- Martinez-Mosquera, D. / Lurjan-Mora, S. / Recalde, H. (2017): Conceptual modeling of Big Data extract processes. In: 2017 International Conference on Information Systems and Computer Science (INCISCOS). Edicator.
- Vaishnav P. (2009): A Survey of Extract-Transform-Load Technology, International Journal of Data Warehousing & Mining, 5(3), 1-27.
- Oditis I. / Bicevska Z. / Bicevskis J. / Karnitis G. (2018), Implementation of NoSQL-based Data Warehouses, Baltic J. Modern Computing, Vol. 6, No. 1, 45-55, <https://doi.org/10.22364/bjmc.2018.6.1.04>
- Vyas S. / Vaishnav P. (2017): A comparative study of various ETL process and their testing techniques in data warehouse, Journal of Statistics and Management Systems.

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Written Assessment: Case Study

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

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Online Tests <input checked="" type="checkbox"/> Guideline

## Project: Extract, Transform and Load Technologies

Course Code: DLMBIESDPDWS01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMBIETLT01, DLMDEBA01, DLMDMDQL01

### Course Description

The focus of this course is to apply previously acquired “Extract, Transform and Load (ETL)” knowledge to a project implementation and reflect on the results. The students will carry out the project based on a given set of requirements and document the results.

### Course Outcomes

On successful completion, students will be able to

- practice and deepen the learned ETL knowledge.
- implement methods for moving data from different sources into a data warehouse.
- design a common data repository and associated ETL process for a data warehouse.
- evaluate the results of the ETL process.
- demonstrate the effective use of technical skills through documentation.
- present the main techniques of ETL and all related procedures.

### Contents

- In this course, students perform and document a hands-on project using the Extract, Transform and Load (ETL) methods using the topics covered in the previous course based on a given set of requirements.

### Literature

#### Compulsory Reading

#### Further Reading

- Ciampa , Brian. (2014): The Data Warehouse Workshop: Providing Practical Experience to the Aspiring ETL Developer. CreateSpace Independent Publishing.
- Guru99. (2021): ETL (Extract, Transform, and Load) Process in Data Warehouse. (URL: <https://www.guru99.com/etl-extract-load-process.html>)
- Kimball, Ralph / Caserta , Joe. (2007): The Data Warehouse ETL Toolkit, Practical Techniques for Extracting, Cleaning, Conforming, and Delivering Data. John Wiley & Sons, Inc.
- Panoply. (2021): 3 Ways to Build An ETL Process with Examples. (URL: <https://panoply.io/data-warehouse-guide/3-ways-to-build-an-etl-process/>)
- Singh , Jaiteg. (2011): Understanding ETL and Data Warehousing: Issues, Challenges and Importance. Role of ETL routines in Quality Data Warehouse Solutions. Lambert.

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Project
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Written Assessment: Project Report

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

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline



# Big Data Engineering

Module Code: DLMBIEBDE

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> <ul style="list-style-type: none"> <li>▪ none</li> <li>▪ DLMDSBDT01</li> </ul>	<b>Study Level</b> MA	<b>CP</b> 10	<b>Student Workload</b> 300 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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## Module Coordinator

Prof. Dr. Christian Müller-Kett (Big Data Technologies) / Prof. Dr. Thomas Zöller (Project: Big Data Technologies)

## Contributing Courses to Module

- Big Data Technologies (DLMDSBDT01)
- Project: Big Data Technologies (DLMBIEBDE01)

## Module Exam Type

<b>Module Exam</b>	<b>Split Exam</b> <u>Big Data Technologies</u> <ul style="list-style-type: none"> <li>• Study Format "myStudies": Oral Assignment</li> <li>• Study Format "Distance Learning": Oral Assignment</li> </ul> <u>Project: Big Data Technologies</u> <ul style="list-style-type: none"> <li>• Study Format "Distance Learning": Written Assessment: Project Report</li> </ul>
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## Weight of Module

see curriculum

### Module Contents

#### Big Data Technologies

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

#### Project: Big Data Technologies

The module is designed to give the students the opportunity to practice what they have learned in the previous course and encounter a number of practical problems that are new for them.

### 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.

#### Project: Big Data Technologies

On successful completion, students will be able to

- experience the learned big data technologies in a project.
- design a Big Data architecture based on given requirements and conditions.
- investigate and gather information from a variety of sources to build a Big Data application.
- apply appropriate techniques and methods to create an Apache Spark cluster.
- demonstrate meaningful use of technical skills by documentation.
- explain which disciplines play an essential role in the context of Big Data Engineering.

#### Links to other Modules within the Study Program

This module is similar to other modules in the fields of Data Science & Artificial Intelligence

#### Links to other Study Programs of the University

All Master Programs in the IT & Technology fields

# Big Data Technologies

Course Code: DLMDSBDT01

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

## Course Description

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

## Course Outcomes

On successful completion, students will be able to

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

## Contents

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

- 2.3 Relational databases
- 2.4 nonSQL, NewSQL databases
- 2.5 Timeseries DB
3. Modern data storage frameworks
  - 3.1 Distributed Filesystems
  - 3.2 Streaming frameworks
  - 3.3 Query frameworks
4. Data formats
  - 4.1 Traditional data exchange formats
  - 4.2 Apache Arrow
  - 4.3 Apache Parquet
5. Distributed Computing
  - 5.1 Cluster-based approaches
  - 5.2 Containers
  - 5.3 Cloud-based approaches

**Literature****Compulsory Reading****Further Reading**

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

**Study Format myStudies**

<b>Study Format</b> myStudies	<b>Course Type</b> Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Oral Assignment

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Online Tests <input checked="" type="checkbox"/> Guideline

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Oral Assignment

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed <input checked="" type="checkbox"/> Creative Lab	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Reader <input checked="" type="checkbox"/> Video	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline

## Project: Big Data Technologies

Course Code: DLMBIEBDE01

Study Level	Language of Instruction and Examination	Contact Hours	CP	Admission Requirements
MA	English		5	DLMDSBDT01

### Course Description

The course is designed to give the students the opportunity to practice what they have learned and encounter a set of practical problems that are new for them. The goal is to implement an Apache Spark project with the learned knowledge.

### Course Outcomes

On successful completion, students will be able to

- experience the learned big data technologies in a project.
- design a Big Data architecture based on given requirements and conditions.
- investigate and gather information from a variety of sources to build a Big Data application.
- apply appropriate techniques and methods to create an Apache Spark cluster.
- demonstrate meaningful use of technical skills by documentation.
- explain which disciplines play an essential role in the context of Big Data Engineering.

### Contents

- In this course, students will conduct and document a Big Data project using the topics covered in the previous course. They will explore and collect information from a variety of sources and design an application using Apache Spark. They will design the architecture and document the implementation of the application.

### Literature

#### Compulsory Reading

#### Further Reading

- Kleppmann, Martin. (2017): Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems. O'Reilly Media.
- Marz , Nathan / Warren, James. (2015): Big Data: Principles and best practices of scalable realtime data systems. Manning Publications.
- Sachdev , Dinesh. (2021): Thinking Big: Developers Guide for Big Data Engineering & Analytics. Independently published.
- SparkByExamples. (2021): Spark By Examples. (URL: <https://sparkbyexamples.com/>)
- Weber , Hans. (2020): Big Data and Artificial Intelligence: Complete Guide to Data Science, AI, Big Data and Machine Learning. Independently published.

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Project
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Written Assessment: Project Report

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

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline



## AI and Mastering AI Prompting

Module Code: DLMEAIMAIP

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

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

### Module Coordinator

Prof. Dr. Claudia Heß (Artificial Intelligence) / N.N. (Project: AI Excellence with Creative Prompting Techniques)

### Contributing Courses to Module

- Artificial Intelligence (DLMAIAI01)
- Project: AI Excellence with Creative Prompting Techniques (DLMPAIECPT01)

### Module Exam Type

Module Exam	Split Exam
	<p><u>Artificial Intelligence</u></p> <ul style="list-style-type: none"> <li>• Study Format "Distance Learning": Exam, 90 Minutes</li> <li>• Study Format "myStudies": Exam, 90 Minutes</li> </ul> <p><u>Project: AI Excellence with Creative Prompting Techniques</u></p> <ul style="list-style-type: none"> <li>• Study Format "Distance Learning": Written Assessment: Project Report</li> </ul>

### Weight of Module

see curriculum

### Module Contents

#### Artificial Intelligence

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

#### 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

This module is similar to other modules in the field of Data Science & Artificial Intelligence

#### Links to other Study Programs of the University

All Master Programs in the IT & Technology field

# Artificial Intelligence

Course Code: DLMAIAI01

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

## Course Description

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

## Course Outcomes

On successful completion, students will be able to

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

## Contents

1. History of AI
  - 1.1 Historical Developments
  - 1.2 AI Winter
  - 1.3 Notable Advances in AI
2. Expert Systems
  - 2.1 Overview Over Expert Systems
  - 2.2 Introduction to Prolog
3. Neuroscience
  - 3.1 The (Human) Brain

3.2 Cognitive Processes

4. Modern AI Systems

4.1 Recent Developments in Hard- and Software

4.2 Narrow vs General AI

4.3 NLP and Computer Vision

5. AI Application Areas

5.1 Autonomous Vehicles & Mobility

5.2 Personalized Medicine

5.3 FinTech

5.4 Retail & Industry

### Literature

#### Compulsory Reading

#### Further Reading

- 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**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Online Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Exam, 90 Minutes

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Practice Exam <input checked="" type="checkbox"/> Online Tests

**Study Format myStudies**

<b>Study Format</b> myStudies	<b>Course Type</b> Lecture
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> yes
<b>Type of Exam</b>	Exam, 90 Minutes

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

<b>Instructional Methods</b>		
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed	<b>Learning Material</b> <input checked="" type="checkbox"/> Course Book <input checked="" type="checkbox"/> Video <input checked="" type="checkbox"/> Audio <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Practice Exam <input checked="" type="checkbox"/> Online Tests

# Project: AI Excellence with Creative Prompting Techniques

Course Code: DLMPAIECPT01

Study Level	Language of Instruction and Examination	Contact Hours	CP	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-thought prompting elicit reasoning in large language models. arXiv. <https://arxiv.org/pdf/2201.11903.pdf>



**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Project
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Written Assessment: Project Report

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

<b>Instructional Methods</b>	
<b>Tutorial Support</b> <input checked="" type="checkbox"/> Course Feed <input checked="" type="checkbox"/> Intensive Live Sessions/Learning Sprint	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline

## Master Thesis

Module Code: DLMMTHES

<b>Module Type</b> see curriculum	<b>Admission Requirements</b> See current study and exam regulations (SPO)	<b>Study Level</b> MA	<b>CP</b> 15	<b>Student Workload</b> 450 h
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<b>Semester / Term</b> see curriculum	<b>Duration</b> Minimum 1 semester	<b>Regularly offered in</b> WiSe/SoSe	<b>Language of Instruction and Examination</b> English
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### Module Coordinator

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

### Contributing Courses to Module

- Master Thesis (DLMMTHES01)
- Colloquium (DLMMTHES02)

### Module Exam Type

<b>Module Exam</b>	<p><b>Split Exam</b></p> <p><u>Master Thesis</u></p> <ul style="list-style-type: none"> <li>• Study Format "Distance Learning": Master Thesis (90)</li> <li>• Study Format "myStudies": Master Thesis (90)</li> </ul> <p><u>Colloquium</u></p> <ul style="list-style-type: none"> <li>• Study Format "myStudies": Colloquium (10)</li> <li>• Study Format "Distance Learning": Colloquium (10)</li> </ul>
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### Weight of Module

see curriculum

**Module Contents****Master Thesis**

- Written Master Thesis

**Colloquium**

- Thesis Defense

**Learning Outcomes****Master Thesis**

On successful completion, students will be able to

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

**Colloquium**

On successful completion, students will be able to

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

**Links to other Modules within the Study Program**

All modules in the Master Program

**Links to other Study Programs of the University**

All Master Programs

## Master Thesis

Course Code: DLMMTHES01

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

### Course Description

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

### Course Outcomes

On successful completion, students will be able to

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

### Contents

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

**Literature****Compulsory Reading****Further Reading**

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

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Thesis
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Master Thesis

<b>Student Workload</b>					
<b>Self Study</b> 405 h	<b>Contact Hours</b> 0 h	<b>Tutorial/Tutorial Support</b> 0 h	<b>Self Test</b> 0 h	<b>Independent Study</b> 0 h	<b>Hours Total</b> 405 h

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline

**Study Format myStudies**

<b>Study Format</b> myStudies	<b>Course Type</b> Thesis
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Master Thesis

<b>Student Workload</b>					
<b>Self Study</b> 405 h	<b>Contact Hours</b> 0 h	<b>Tutorial/Tutorial Support</b> 0 h	<b>Self Test</b> 0 h	<b>Independent Study</b> 0 h	<b>Hours Total</b> 405 h

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline

## Colloquium

Course Code: DLMMTHES02

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

### Course Description

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

### Course Outcomes

On successful completion, students will be able to

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

### Contents

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

### Literature

#### Compulsory Reading

#### Further Reading

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



**Study Format myStudies**

<b>Study Format</b> myStudies	<b>Course Type</b> Thesis Defense
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Colloquium

<b>Student Workload</b>					
<b>Self Study</b> 45 h	<b>Contact Hours</b> 0 h	<b>Tutorial/Tutorial Support</b> 0 h	<b>Self Test</b> 0 h	<b>Independent Study</b> 0 h	<b>Hours Total</b> 45 h

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline

**Study Format Distance Learning**

<b>Study Format</b> Distance Learning	<b>Course Type</b> Thesis Defense
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<b>Information about the examination</b>	
<b>Examination Admission Requirements</b>	<b>Online Tests:</b> no
<b>Type of Exam</b>	Colloquium

<b>Student Workload</b>					
<b>Self Study</b> 45 h	<b>Contact Hours</b> 0 h	<b>Tutorial/Tutorial Support</b> 0 h	<b>Self Test</b> 0 h	<b>Independent Study</b> 0 h	<b>Hours Total</b> 45 h

<b>Instructional Methods</b>	
<b>Learning Material</b> <input checked="" type="checkbox"/> Slides	<b>Exam Preparation</b> <input checked="" type="checkbox"/> Guideline