

Master of Science (M.Sc.)
“Mannheim Master in Data Science“

University of Mannheim

– Module catalog –

for students starting before spring 2020

Academic Year
HWS 2020/ FSS 2021

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Foreword

This document describes the courses that will be offered in the academic year 2020/2021 for students studying M. Sc. Mannheim Master in Data Science before spring 2020. You can find the Examination Regulations on the website of the Student Services (Studienbüros):

<http://www.uni-mannheim.de/studienbueros/pruefungen/pruefungsordnungen/>

It is possible that additional courses will be made available during the course of the academic year. These will be published in an appendix available on the following web page:

<https://www.wim.uni-mannheim.de/studium/studienorganisation/mannheim-master-in-data-science/#c112237>

A. Overview and Study plan

| | | ECTS |
|-------------------------------|------------------------------------------------------------------------|---------|
| Fundamentals | “Fundamentals” courses with at most 14 ECTS | 0 – 14 |
| Data Management | Minimum of four “Data Management” courses | 24 – 36 |
| Data Analytics Methods | Minimum of four “Data Analytics Methods” courses with at least 30 ECTS | 30 – 54 |
| Project | Either a “Team Project” course or an “Individual Project” course | 8 – 12 |
| Seminar | One Seminar course | 4 |
| Master Thesis | Six-months-long written academic assignment | 30 |
| Total | | 120 |

General constraints:

1. Courses with 0-14 ECTS can be taken (0 to 14 ECTS)
2. 4 to 6 Data Management courses must be taken (24 to 36 ECTS)
3. Data Analytics Methods courses worth a combined 30 to 54 ECTS must be taken
4. You must either take a Team Project course or an Individual Project course
5. You must take a Seminar
6. A total of 78 ECTS must be taken within the Fundamentals, Data Management and Data Analytics Methods courses combined when you take an Individual Project. If you take a Team Project, that total is 74 ECTS. In any case, your combined total of all courses (including the Seminar and the Master Thesis) must be at least 120 ECTS.

Abbreviations:

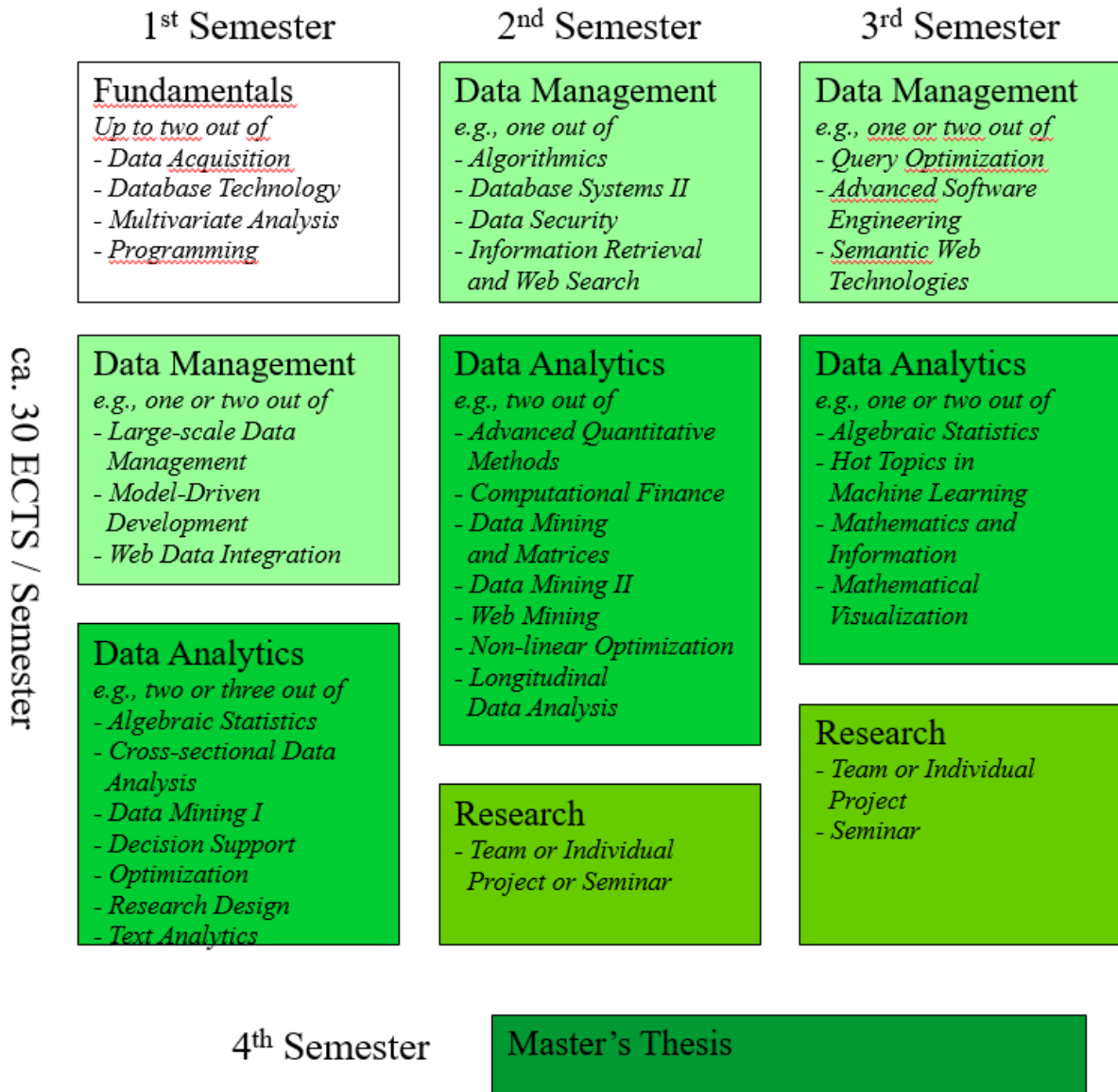
HWS (Herbst-/Wintersemester): Course is offered in the respective Fall semester

FSS (Frühjahrs-/Sommersemester): Course is offered in the respective Spring semester

FSS/HWS: course is offered both in Spring semester and Fall semester

Example study plan

Please note: this is just an example - your actual study plan may vary depending on the semester in which you start, your preferences, etc.



B. Fundamentals

1. Overview

| Module no. | Name of Module | Offered | Language | ECTS | Page |
|------------|---------------------------------------------|---------|----------|------|------|
| CS 450 | Programming Course | HWS | E | 6 | 7 |
| CS 460 | Database Technology | FSS | E | 6 | 9 |
| | Multivariate Analyses | HWS | E | 6 | PS* |
| | Tutorial Multivariate Analyses | HWS | E | 2 | PS* |
| | Empirische Methoden der Politikwissenschaft | HWS | G | 6 | PW* |

* For a detailed description, please see the module catalogs of the respective following degree programs:

- PW: B.A. Politikwissenschaft, <https://www.sowi.uni-mannheim.de/en/academics/students/political-science/ba-in-political-science/> (only available in German)
- PS: M.A. Political Science, <https://www.sowi.uni-mannheim.de/en/academics/students/political-science/ma-in-political-science/>

2. Detailed descriptions

| CS 450 | Programming Course |
|-------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Form of module | Lecture and accompanying practical sessions |
| Type of module | Computer Science Fundamental |
| Level | Master |
| ECTS | 6 |
| Workload | Hours per semester present: 84h (6 SWS) |
| | Self-study: 84h per semester <ul style="list-style-type: none"> • 28h: pre and post lecture studying and revision • 56h: preparation and presentation of small software projects |
| Prerequisites | - |
| Aim of module | The course deals with the basic concepts of (object-oriented) programming using Java. In addition, some advanced topics are covered such as writing GUI applications and dealing with external data (XML, databases): <ul style="list-style-type: none"> • primitive data types, variables, operators, expressions • control flow statements • complex data types (arrays), references • classes • OO concepts (information hiding, inheritance, polymorphism, abstract classes, interfaces) • Java API • Exceptions • IO using streams • Java Collections • GUI programming • processing of XML documents • database access (SQL, JDOM) |
| Learning outcomes and qualification goals | Expertise: After taking the course, students will be familiar with the basic concepts of (object-oriented) programming in Java. |
| | Methodological competence: Students will acquire the skills to develop high-quality console and GUI Java applications of moderate size. |

| | |
|---------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | Personal competence: <ul style="list-style-type: none"> • ability to work independently • ability to work in a team |
| Media | Beamer, PC (Linux), printed lecture slides |
| Literature | <ul style="list-style-type: none"> • Learning Java (P. Niemeyer, P. Leuck), O'Reilly UK Ltd. • Core Java Volume I—Fundamentals (C.S. Horstmann), Prentice Hall |
| Methods | lectures, tutorials, independent study |
| Form of assessment | written examination (Programmiertestat) |
| Admission requirements for assessment | successful completion and presentation of at least 75% of the weekly assessments |
| Duration of assessment | 180 minutes |
| Language | English |
| Offering | Fall semester |
| Lecturer | Dr. Ursula Rost |
| Person in charge | Dr. Ursula Rost |
| Duration of module | 1 semester |
| Further modules | - |
| Range of application | MMDS |
| Semester | 1 st /2 nd semester |

| CS 460 | Database Technology |
|-------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Form of module | Lecture with Exercise |
| Type of module | MMDS Fundamental |
| Level | Master |
| ECTS | 6 |
| Workload | Hours per semester present: 56 h (4 SWS) |
| | Self-study per semester: 98 h <ul style="list-style-type: none"> • 70 h: pre and post lecture studying and revision • 28 h: examination preparation |
| Prerequisites | - |
| Aim of module | The course provides an introduction to relational database systems. The course will cover the following topics: <ul style="list-style-type: none"> • Principles of data storage • Database query languages (SQL) • Relational modeling • Keys and normal forms • Hash and index structures • Transactions and concurrency |
| Learning outcomes and qualification goals | Expertise: Basic understanding of relational data modeling and database design, as well as the functionality of relational database management systems, query handling, and transaction management. (BK4, BK5, BK6, BK7) |
| | Methodological competence: Abstraction, modeling, complexity consideration. (BF1, BF2) |
| | Personal competence: Understanding the role of data management in enterprises. (BK01, BK02) |
| Media | Electronic slides and exercise sheets |
| Literature | Avi Silberschatz, Henry F. Korth, S. Sudarshan: Database System Concepts |

| | |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methods | The course consists of a lecture together and exercises. The exercises encompass both theoretical exercises as well as practical assignments, which are conducted with a free modern database management system and allow the students to deepen their theoretical understanding of the course contents, as well as to gather hands-on experience with database management systems. |
| Form of assessment | Written examination |
| Admission requirements for assessment | - |
| Duration of assessment | 60 minutes |
| Language | English |
| Offering | Spring semester |
| Lecturer | Prof. Dr. Heiko Paulheim |
| Person in charge | Prof. Dr. Heiko Paulheim |
| Duration of module | 1 semester |
| Further modules | Database Systems II, Transaktionssysteme, Anfrageoptimierung, Large Scale Data Management |
| Range of application | MMDS |
| Semester | 1 st /2 nd semester |

C. Data Management

1. Overview

| Module no. | Name of Module | Offered | Language | ECTS | Page |
|------------|--------------------------------------|---------|----------|---------|------|
| AC 651 | Additional Course – Data Management | HWS | E | AC 651* | 12 |
| CS 500 | Advanced Software Engineering | HWS | E | 6 | BI* |
| CS 530 | Database Systems II | FSS | E | 6 | BI* |
| CS 550 | Algorithmics | FSS/HWS | E | 6 | BI* |
| CS 560 | Large Scale Data Management | HWS | E | 6 | BI* |
| CS 600 | Model-driven Development | HWS | E | 6 | BI* |
| CS 652 | Data Security and Privacy | HWS/FSS | E | 6 | BI* |
| IE 630 | Query Optimization | FSS | E | 6 | BI* |
| IE 650 | Semantic Web Technologies | HWS | E | 6 | BI* |
| IE 663 | Information Retrieval and Web Search | FSS | E | 3 | BI* |
| IE 670 | Web Data Integration | HWS | E | 3 | BI* |
| IE 691 | Information Retrieval Project | FSS | E | 3 | BI* |
| IE 683 | Web Data Integration Project | HWS | E | 3 | BI* |

* For a detailed description, please see the module catalog of the respective following degree programs:

- BI: M.Sc. Business Informatics, <https://www.wim.uni-mannheim.de/studium/studienorganisation/m-sc-business-informatics/>

| AC 651 | Additional Course – Data Management |
|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Form of module | Depends on course |
| Level | Master |
| ECTS | Max. 18 |
| Workload | Depends on course |
| Prerequisites | Depends on course |
| Aim of module | The course falls into the data management area of the MMDS and covers topics related to data management, but is not directly equivalent to any course in the MMDS module catalogue. The course level equals a regular course in MMDS study program. The module can be taken either at the University of Mannheim or at any other university in Germany or abroad. |
| Learning outcomes and qualification goals | Depends on course |
| Media / Literature / Methods / Form and duration of assessment | Depends on course |
| Language | English preferred, but any other language possible if Mannheim faculty member is able to identify content and level |
| Offering | Spring semester / Fall semester |
| Lecturer | Lecturer at the host university |
| Person in charge | Lecturer at the host university |
| Duration of module | 1 Semester |
| Further modules | - |
| Range of application | MMDS |
| Semester | 2 nd /3 rd /4 th semester |

D. Data Analytics Methods

1. Overview

| Module no. | Name of Module | Offered | Language | ECTS | Page |
|------------|--------------------------------------------|-----------|----------|---------|------|
| AC 652 | Additional Course – Data Analytics Methods | HWS | E | AC 652* | 15 |
| CS 646 | Higher Level Computer Vision | FSS | E | 6 | BI* |
| CS 647 | Image Processing | HWS | E | 6 | BI* |
| IE 500 | Data Mining I | FSS/HWS | E | 6 | BI* |
| IE 560 | Decision Support | HWS | E | 6 | BI* |
| IE 661 | Text Analytics | HWS | E | 6 | BI* |
| IE 671 | Web Mining | FSS | E | 3 | BI* |
| IE 672 | Data Mining II | FSS | E | 6 | BI* |
| IE 675 | Machine Learning | HWS | E | 6 | BI* |
| IE 674 | Hot Topics in Machine Learning | FSS | E | 6 | BI* |
| IE 684 | Web Mining Project | FSS | E | 3 | BI* |
| IE 689 | Relational Learning | HWS | E | 6 | BI* |
| IS 514 | Process Mining and Analytics | HWS | E | 6 | MMM* |
| MAB 504 | Mathematics and Information | irregular | G | 8 | MBE* |
| MAB 508 | Algebraische Statistik | irregular | G/E | 8 | MBE* |
| MAC 404 | Optimierung | HWS | G | 8 | WM* |
| MAC 502 | Computational Finance | FSS | G/E | 6 | MBE* |
| MAC 505 | Mathematische Visualisierung | irregular | G/E | 8 | MBE* |
| MAC 507 | Nichtlineare Optimierung | FSS | G/E | 6 | MBE* |
| | Lecture Cross Sectional Data Analysis | HWS | E | 6 | Soc* |
| | Tutorial Cross Sectional Data Analysis | HWS | E | 3 | Soc* |
| | Lecture Advanced Quantitative Methods | FSS | E | 6 | PS* |
| | Tutorial Advanced Quantitative Methods | FSS | E | 2 | PS* |
| | Lecture Longitudinal Data Analysis | FSS | E | 6 | Soc* |
| | Tutorial Longitudinal Data Analysis | FSS | E | 3 | Soc* |

| | | | | | |
|--|--------------------------|-----|---|---|------|
| | Lecture Research Design | HWS | E | 6 | Soc* |
| | Tutorial Research Design | HWS | E | 3 | Soc* |

* For a detailed description, please see the module catalogs of the respective following degree programs:

- BI: M.Sc. Business Informatics, <https://www.wim.uni-mannheim.de/studium/studienorganisation/m-sc-business-informatics/>
- WM: B.Sc. Wirtschaftsmathematik, <https://www.wim.uni-mannheim.de/studium/studienorganisation/b-sc-wirtschaftsmathematik/> (only available in German)
- MBE: M.Sc. Mathematics in Business and Economics, <https://www.wim.uni-mannheim.de/studium/studienorganisation/m-sc-wirtschaftsmathematik/> (only available in German)
- PS: M.A. Political Science, <https://www.sowi.uni-mannheim.de/en/academics/students/political-science/ma-in-political-science/>
- Soc: M.A. Sociology, <https://www.sowi.uni-mannheim.de/en/academics/students/sociology/ma-in-sociology/>

| AC 652 | Additional Course – Data Analytics Methods |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Form of module | Depends on course |
| Level | Master |
| ECTS | Max. 18 |
| Workload | Depends on course |
| Prerequisites | Depends on course |
| Aim of module | The course falls into the data analytics methods area of the MMDS and covers topics related to data analytics methods, but is not directly equivalent to any course in the MMDS module catalogue. The course level equals a regular course in MMDS study program. The module can be taken either at the University of Mannheim or at any other university in Germany or abroad. |
| Learning outcomes and qualification goals | Depends on course |
| Media / Literature / Methods / Form and duration of assessment | Depends on course |
| Language | English preferred, but any other language possible if Mannheim faculty member is able to identify content and level |
| Offering | Spring semester / Fall semester |
| Lecturer | Lecturer at the host university |
| Person in charge | Lecturer at the host university |
| Duration of module | 1 Semester |
| Further modules | - |
| Range of application | MMDS |
| Semester | 2 nd /3 rd /4 th semester |

E. Projects

1. Overview

| Module no. | Name of Module | Offered | Language | ECTS | Page |
|------------|--------------------|-----------|----------|------|------|
| TP 500 | Team Project | FSS/HWS | G/E | 12 | BI* |
| IP 500 | Individual Project | irregular | G/E | 8 | 17 |

* For a detailed description, please see the module catalogs of the respective following degree programs:

- BI: M.Sc. Business Informatics, <https://www.wim.uni-mannheim.de/studium/studienorganisation/m-sc-business-informatics/>

2. Detailed descriptions

| IP 500 | Individual Project |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Form of module | Project |
| Type of module | Individual Project |
| Level | Master |
| ECTS | 8 |
| Workload | Self study: 240 h per semester |
| Prerequisites | Depends on topic |
| Aim of Modules | The student solves a practical problem individually. The student has to analyse and refine the problem and come up with a project plan for developing a concrete solution. Concrete topics for projects are defined by the supervisors and offered to the students who can apply for different topics. Problem area and techniques involved depend on the expertise of the offering chair. |
| Learning outcomes and qualifications goals | <p>Depending on the actual topic of the project, participants will acquire ☐</p> <ul style="list-style-type: none"> • in-depth knowledge in a certain application of data science • knowledge about methods and technologies typically applied in the application area ☐ • knowledge about practical problems and challenges when applying a certain technique in a given application area <p>Participants will learn to ☐</p> <ul style="list-style-type: none"> • refine a given problem statement by analysing requirements and the state of the art using techniques like literature research and expert interviews. ☐ • define a workplan including tasks, milestones, deliverables and resources and continually assess and modify the plan according to the actual progress of the work. |
| Media | Depends on project |
| Literature | Depends on topic |
| Methods | Self study, presentations |
| Form of Assessment | Final report and presentation |

| | |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Admission requirements for assessment | - |
| Duration of Assessment | 15 minutes (presentation) |
| Language | English/German |
| Offering | Spring semester/Fall semester |
| Lecturer | Professors of the Institute of School of Business Informatics and Mathematics or of the School of Social Sciences |
| Person in Charge | A professor of the Institute of School of Business Informatics and Mathematics of the School of Social Sciences |
| Duration of module | 1 semester |
| Further modules | - |
| Range of Applications | MMDS |
| Semester | 1 st /2 nd /3 rd semester |

F. Seminar

1. Overview

| Module no. | Name of Module | Offered | Language | ECTS | Page |
|------------|----------------------------------------------------|---------|----------|---------|------|
| AC 653 | Additional Course – Projects and Seminars | HWS | E | AC 653* | 20 |
| CS 701 | Selected Topics in Algorithmics and Cryptography | FSS | E | 4 | BI* |
| CS 704 | Master Seminar Artificial Intelligence | HWS/FSS | E | 4 | BI* |
| CS 705 | Datenbankseminar | HWS/FSS | G/E | 4 | BI* |
| CS 707 | Seminar Data and Web Science | HWS/FSS | E | 4 | BI* |
| CS 708 | Seminar Software Engineering | HWS/FSS | E | 4 | BI* |
| CS 709 | Seminar Text Analytics | HWS/FSS | G/E | 4 | BI* |
| CS 710 | Selected Topics in Data Science | FSS | G/E | 4 | BI* |
| CS 715 | Large-Scale Data Integration Seminar (Prof. Bizer) | FSS | E | 4 | BI* |
| CS 716 | IT-Security | HWS | E | 4 | BI* |
| CS 717 | Master Seminar on Computer Vision | HWS | E | 4 | BI* |
| CS 718 | AI and Data Science in Fiction and Society | HWS | E | 4 | BI* |
| CS 719 | Seminar on Process Analysis | HWS/FSS | E | 4 | BI* |
| IE 704 | Seminar AI Systems Engineering | HWS/FSS | E | 4 | BI* |

* For a detailed description, please see the module catalogs of the respective following degree programs:

- BI: M.Sc. Business Informatics, <https://www.wim.uni-mannheim.de/studium/studienorganisation/m-sc-business-informatics/>

| AC 653 | Additional Course – Projects and Seminars |
|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Form of module | Depends |
| Level | Master |
| ECTS | Max. 18 |
| Workload | Depends |
| Prerequisites | Depends |
| Aim of module | The course equals a seminar in the MMDS study program. The module can be taken either at the University of Mannheim or at any other university in Germany or abroad. |
| Learning outcomes and qualification goals | Depends on course |
| Media / Literature / Methods / Form and duration of assessment | Depends |
| Language | English preferred, but any other language possible if Mannheim faculty member is able to identify content and level |
| Offering | Spring semester / Fall semester |
| Lecturer | Lecturer at the host university |
| Person in charge | Lecturer at the host university |
| Duration of module | 1 Semester |
| Further modules | - |
| Range of application | MMDS |
| Semester | 2 nd /3 rd /4 th semester |

G. Master Thesis

| | Master Thesis |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Form of module | Master Thesis |
| Type of module | Thesis |
| Level | Master |
| ECTS | 30 |
| Workload | Self study: 840 h per semester |
| Prerequisites | - |
| Aim of Modules | Develop a deep understanding of an advanced topic of data science |
| Learning outcomes and qualifications goals | Expertise: The student has a deep understanding of an advanced topic. (MK1) |
| | Methodological competence: The student is familiar with methods for analysing and independently solving advanced, complex problems. (MK1, MK2, MK3) |
| | Personal competence: The student has the capability to understand, analyse and independently find solutions to advanced, complex problems. The student has the capability to assess and understand the state-of-the-art in business informatics and adapt the latest technologies and methods to solve real world problems. The student is able to present a complex topic in written and oral form in a clear and understandable way. (MF1, MF2, MF3, MF4, MKO2, MKO3) |
| Media | Various |
| Literature | Topic dependent |
| Methods | Independent research work |
| Form of Assessment | Written thesis |
| Admission requirements for assessment | To be permitted to write the master thesis, the student is to obtain at least 60 ECTS |
| Duration of Assessment | - |

| | |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Langauges | English only |
| Offering | Every semester |
| Person in Charge | Examiners: University teachers, auxiliary professors, honorary professors and senior academic staff members of the School of Business informatics and mathematics or of the School of Social Sciences |
| Duration of module | 1 semester |
| Further modules | - |
| Range of Applications | MMDS |
| Semester | 4 th semester |

Abbreviations

Explanation of abbreviations

Knowledge

This degree program provides students with a solid theoretical foundation as well as practical skills for data management and data analytics. The courses are divided into two groups – fundamental courses and advanced courses. After studying optional fundamental courses in computer science and empirical social sciences, in their advanced courses students can focus on the concepts and methods of computers science and advanced empirical methods and the application of these methods. In addition to the regular lecture courses, students participate in a one or two semester team project or individual project.

During their studies -

(MK1) all students develop a deep understanding of the relevant concepts, methods and problem solving strategies used in different application domains.

(MK2) technology-oriented students learn the concepts, algorithms and strategies used to solve concrete, practical application-oriented problems in informatics.

(MK3) social sciences-oriented students develop a deep understanding of how to set up, analyse and interpret advanced empirical research questions.

As part of this education, students become familiar with a wide range of models, modelling languages, methods and tools. Regardless of their specialization, students also learn how to collect, structure, manipulate, prepare, interpret, communicate and use data, information and knowledge.

Capabilities

After completing their studies, students have the ability to –

(MF1) apply a wide range of abstraction and analysis techniques.

(MF2) understand, interpret, describe and present relevant scientific publications.

(MF3) exploit the latest scientific results.

(MF4) independently tackle problems in data management and analytics and describe their results in a structured, written form.

(MF5) continue their studies at the PhD level, if their results are of sufficient quality.

Competencies

After completing their studies, students have the competences needed to –

(MKO1) apply their knowledge and capabilities to solve specific problems in a team context.

(MKO2) use their interdisciplinary education to mediate between technical and non-technical individuals.

(MKO3) evaluate the latest changes in programming languages, systems, models and, wherever possible, exploit them to develop better solutions to data-science related problems.