

Handbook of Modules for the Master Study Program Data Science (Terms of study 2026)

updated October 2026

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Overview of modules

Compulsory courses

No.	Module Name	Courses	ECTS points
MD 1	STATISTICAL THEORY	Statistical Theory	9
MD 2	ADVANCED STATISTICAL LEARNING	Advanced Statistical Learning	9
MD 3	ADVANCED PROGRAMMING IN R	Advanced R: Theory, Concepts, and Paradigms	4.5
		Visualization of Complex Data Structures with R	4.5
MD 4	DATA SCIENCE IN PRACTICE	Data Science in Context	3
		Advanced Programming Course	3
MD 5	PROJECT WORK	Case Studies / External Internship Seminar	8
			4
MD 9	MASTER THESIS	Master Thesis	27
		Advanced Seminar	3

Elective Areas

CATALOGUE OF MODULES	No.	Module Name	ECTS points
ADVANCED MACHINE LEARNING (Choose modules with a total of 18 ECTS points)	MD 6-1	Basis Module Advanced Machine Learning 1 - 2	9
	MD 6-2		
	MD 6-3	Specialized Module Advanced Machine Learning 1 - 4	4.5
	MD 6-4		
	MD 6-5		
	MD 6-6		
APPLIED DATA SCIENCE (Choose modules with a total of 9 ECTS points)	MD 7-1	Applied Data Science 1	9
	MD 7-2	Applied Data Science 2 - 3	4.5
	MD 7-3		
METHODICAL DATA SCIENCE (choose modules with a total of 18 ECTS points)	MD 8-1	Methodical Data Science 1 - 2	9
	MD 8-2		
	MD 8-3	Methodical Data Science 3 - 6	4.5
	MD 8-4		
	MD 8-5		
	MD 8-6		

Possible stipulates in case of conditional admission

No.	Module Name	Courses	ECTS points
MD Stip-1	PROBABILITY	Reading Course Probability	5
MD Stip-2	INFERENCE	Reading Course Inference	5
MD Stip-3	LINEAR MODELS	Reading Course Linear Models	5
MD Stip-4	INTRODUCTION TO STATISTICAL LEARNING	Introduction to Statistical Learning	5

Notes

- As elective courses, also courses taught in German can be taken.
- For courses with a written exam according to this handbook, there have to be two examination dates during the semester, generally one of them towards the end of the lecture-free period. Students who did not pass or participate in the first date may participate in the second. If the examination is not passed at the second date, there is no right to a further attempt during the same semester, even if the student has not taken the exam at the first regular date. For courses that are offered every semester, and not only once per year, it is possible to have only one exam after each lecture period, resulting in a total of two exams per year.
- Course type abbreviations:
 - L: Lecture
 - T: Tutorial
 - S: Seminar
 - P: Practical course

Preface on dissemination of skills

The overarching goal of education at the departments of statistics, computer science, and mathematics at TU Dortmund University is methodological competence. Students should not learn methodology as if from a recipe book, but rather recognize the connections and common structures of the various statistical methods.

Understanding of statistical methodology cannot be acquired by simple memorizing, but mostly by exercises and application to practical questions and problems. This is usually done in tutorials accompanying all lectures. Therefore, they are a central part of the education.

Apart from understanding of the lectures' contents, the accompanying tutorials impart strategies of learning: the students recognize the application of methods to practical questions as the easiest way of understanding. Writing out answers and solutions to exercises improves the ability to formulate propositions of statistical methodology and the general capability of expression. Application to real data is only possible by means of software. Therefore, after basic training in earlier phases of study, computational application of studied methods is required in the courses. Self-discipline and time management are trained by periodic and strict deadlines for finishing exercises. **The exercises are not exclusively theoretical, but also include case studies, data applications, and simulation experiments. Through these components, the students gain a deeper appreciation of the theoretical concepts presented in the lectures and also refine their programming skills.**

Modern statistical and Data Science work is inconceivable without hands-on application of the methods in statistical computing languages such as R and Python. Our assessments will therefore also regularly ask students to demonstrate that they know how to translate abstract methodology to real-world applications using real data. In the elective courses, students can extend their R and Python programming skills and gain proficiency in other programming languages.

Various examination modes are provided in the regulations. In particular, credit points may be obtained by the exercises mentioned above and by oral presentations. Communication skills and the ability to describe issues of statistical methodology and data science are trained by oral exams. Written exams require the methods' practical application.

Perhaps the most important soft skills in statistics and data analysis are communication and teamworking skills. Expedient data analysis and evaluation can only be achieved if all aspects of

the data and problems are openly discussed between all the participants. The Department of Statistics encourages these abilities by instructions to teamwork in various ways and by special tutorials held by fellow students. This also serves the study objectives of personal development and the ability to engage in social activities.

A semester abroad also serves to develop such general, interdisciplinary skills. Hence, students are strongly encouraged to take some courses at a foreign partner university. In particular, the 3rd semester is suitable in this regard. Such international exchanges are for example supported by the ERASMUS program (https://www.statistik.tu-dortmund.de/erasmus_en.html)

PROVISIONAL VERSION!

Recommended course of study

Start of study in winter semester

1 st semester		2 nd semester		3 rd semester		4 th semester	
Module	ECTS	Module	ECTS	Module	ECTS	Module	ECTS
MD 1: Statistical Theory Statistical Theory (4L + 2T)	9	MD 2: Advanced Statistical Learning Advanced Statistical Learning (4V + 2T)	9	MD 5: Project Work Advanced Case Studies (4P) or External Internship Seminar	8 4	MD 9: Master Thesis Master Thesis Advanced Seminar	30
MD 7: Applied Data Science One elective course (4L + 2T) or Two elective courses (2L + 1T)	9	MD 6: Advanced Machine Learning One elective course (4L + 2T) or Two elective courses (2L + 1T)	9	One elective course (4L + 2T) or Two elective courses (2L + 1T)	9		
MD 4 Data Science in Practice Data Science in Context (2L) Advanced Programming Course (2L)	3 3	MD 8: Methodical Data Science One elective course (4L + 2T) or Two elective courses (2L + 1T)	9	One elective course (4L + 2T) or Two elective courses (2L + 1T)	9		
MD 3: Advanced Programming in R Advanced R: Theory, Concepts, and Paradigms (2L + 1T)	4.5	Visualization of Complex Data Structures (2L + 1T)	4.5				
28.5		31.5		30		30	

Advanced Statistics Specialization Data Science Tools Independent work/presentation

Start of study in summer semester

1 st semester		2 nd semester		3 rd semester		4 th semester	
Module	ECTS	Module	ECTS	Module	ECTS	Module	ECTS
MD 2: Advanced Statistical Learning Advanced Statistical Learning (4V + 2T)	9	MD 1: Statistical Theory Statistical Theory (4L + 2T)	9	MD 5: Project Work Advanced Case Studies (4P) or External Internship Seminar	8 4	MD 9: Master Thesis Master Thesis Advanced Seminar	30
MD 7: Applied Data Science One elective course (4L + 2T) or Two elective courses (2L + 1T)	9	MD 8 Methodical Data Science One elective course (2L + 2T)		4.5	One elective course (4L + 2T) and One elective course (2L + 1T)	9 4.5	
MD 6: Advanced Machine Learning One elective course (4L + 2T) or Two elective courses (2L + 1T)	9	One elective course (4L + 2T) or Two elective courses (2L + 1T)		9			
MD 4 Data Science in Practice Advanced Programming Course (2L)	3	Data Science in Context (2L)		3			
		MD 3: Advanced Programming in R Visualization of Complex Data Structures (2L + 1T)				4.5	
		Advanced R: Theory, Concepts, and Paradigms (2L + 1T)				4.5	
30		30		30		30	

Advanced Statistics

Specialization

Data Science Tools

Independent work/presentation

Compulsory Modules

Module MD 1: Statistical Theory					
Degree program: Master Data Science					
Interval: Winter semester, annual	Duration: 1 semester	Study phase		CP 9	Workload 270h
		Winter start 1 st semester	Summer start 2 nd semester		
1	Module structure:				
	No.	Element / course	Type	CP	Weekly contact hours
	1a	Lecture Statistical Theory	L	6	4
	1b	Tutorial Statistical Theory	T	3	2
2	Language of instruction: English.				
3	Teaching content: The Statistical Theory module covers the main topics of basic statistical theory and consists of the two blocks 'Probability Theory' and 'Decision Theory'. The block 'Probability Theory' gives an introduction to measure theory and stochastics, necessary to formalize the questions discussed in statistical theory. The block 'Decision Theory' introduces the basic concepts associated with statistical tests. Possible topics include: decision rules, Bayes estimator, exponential families, the Neyman-Pearson lemma, two-tailed tests, Wald-tests, conditional tests, sequential hypothesis testing.				
4	Competencies: Participants learn to use the formal language of statistics and gain knowledge of fundamental concepts in stochastics, decision theory and mathematical statistics, which are required in order to analyze, apply and further develop statistical procedures.				
5	Examinations: Graded exam.				
6	Types of examinations and performances: Written exam.				
7	Recommended knowledge: None.				
8	Formal requirements: None.				
9	Module type and applicability of the module: Compulsory module in Master Data Science				
10	Module coordinator: Prof. Dr. M. Demetrescu, Prof. Dr. C. Jentsch		Responsible department: Department of Statistics		
11	Literature: Will be announced in the lecture.				
12	Further Information: Free exam trial: If you take the Statistical Theory exam during your first two semesters and you fail the exam, the exam counts as if it has not been taken. If you take the exam two times during this period, both attempts count as not taken. More information on this is in the terms of studies.				

Module MD 2: Advanced Statistical Learning																				
Degree program: Master Data Science																				
Interval: Summer semester, annual	Duration: 1 semester	Study phase		CP 9	Workload 270h															
		Winter start 2 nd semester	Summer start 1 st semester																	
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1a</td><td>Lecture Advanced Statistical Learning</td><td>L</td><td>6</td><td>4</td></tr><tr><td>1b</td><td>Tutorial Advanced Statistical Learning</td><td>T</td><td>3</td><td>2</td></tr></table>					No.	Element / course	Type	CP	Weekly contact hours	1a	Lecture Advanced Statistical Learning	L	6	4	1b	Tutorial Advanced Statistical Learning	T	3	2
No.	Element / course	Type	CP	Weekly contact hours																
1a	Lecture Advanced Statistical Learning	L	6	4																
1b	Tutorial Advanced Statistical Learning	T	3	2																
2	Language of instruction: English.																			
3	Teaching content: The concepts of the statistical learning beginner's course from the Bachelor program (BD 10) are enhanced and expanded. On the one hand, the general concepts of Hypothesis Space, Capacity, Loss, Risk Minimization and Course of Dimensionality are introduced in depth and illustrated with examples by using classical learners for regression and classification. On the other hand, advanced classes of models such as, for example, advanced boosting, deep learning, self-supervised learning, Bayesian inference and kernel methods are introduced. Moreover, the relevance and limitations of those are shown, in particular, with regard to large data sets (big data).																			
4	Competencies: The students understand the general concepts of Statistical Learning. They are familiar with advanced models and are aware of their limitations. They are able to adapt methods to unusually structured data, to choose appropriate methods for real data and apply them by means of statistical software.																			
5	Examinations: Graded exam. As a prerequisite for admission, a coursework must be achieved. Details will be announced by the respective lecturer in the first lecture.																			
6	Types of examinations and performances: Written exam.																			
7	Recommended knowledge: None.																			
8	Formal requirements: None.																			
9	Module type and applicability of the module: Compulsory module in Master Data Science																			
10	Module coordinator: Prof. Dr. P. Bürkner, Prof. Dr. A. Groll, Prof. Dr. A. Marx		Responsible department: Department of Statistics																	
11	Literature: Will be announced in the lecture.																			
12	Further Information: None.																			

Module MD 3: Advanced Programming in R						
Degree program: Master Data Science						
Interval: Annual		Duration: 2 semesters	Study phase:		CP 9	Workload 270h
			Winter start 1 st to 2 nd semester	Summer start 2 nd to 3 rd semester		
1	Module structure:					
	No.	Element / course		Type	CP	Weekly contact hours
	1a	Lecture Advanced R: Theory, Concepts, and Paradigms		L	3	2
	1b	Tutorial Advanced R: Theory, Concepts, and Paradigms		T	1.5	1
	2a	Lecture Visualization of Complex Data Structures with R		L	3	2
	2b	Tutorial Visualization of Complex Data Structures with R		T	1.5	1
2	Language of instruction: English.					
3	Teaching content: The course "Advanced R: Theory, Concepts, and Paradigms" assumes prior programming knowledge in R or a similar programming language and focuses on the theoretical concepts of the language. It begins with an introduction to the basics of how computers work. The first part explores the internal mechanisms of R, including data types, data structures, environments, functions, and parsing. The aim is to understand how these elements are implemented in R and their implications for users. The second part examines programming paradigms such as imperative, object-oriented, and functional programming, along with their implementation in R. The course Visualization of Complex Data Structures introduces students to the visual perception and processing of information and deals with the suitability of graphics in various situations. Advanced methods for the visualization of complex data and processes based on methods of applied mathematics, pattern recognition and data analysis as well as graphical data processing are covered. Both univariate and multivariate quantitative as well as qualitative and categorical variables are visualized at different levels of abstraction. Efficient algorithms for the realization of the procedures are presented, which are based on a broad spectrum of methods.					
4	Competencies: Students will understand, analyze, and evaluate the theoretical foundations and internal mechanisms of R, including its core components and programming paradigms. This deep conceptual knowledge may also support their ability to approach other programming languages with similar analytical rigor. The students gain specialized knowledge on a software package or a programming language and apply methods from statistics and data analysis to real data using their own program code. They adopt unknown computation techniques. The students know the important aspects of their profession. Students are able to solve complex visualization tasks. To do this, they combine methods that are available in existing systems in an in an engineering-like manner and apply these.					
5	Examinations: Two accumulated graded exams.					
6	Types of examinations and performances: Written exams.					
7	Recommended knowledge: Basic knowledge in programming, ideally in R.					
8	Formal requirements: None.					
9	Module type and applicability of the module: Compulsory module in Master Data Science.					
10	Module coordinator: Dr. D. Horn			Responsible department: Department of Statistics		
11	Literature: Will be announced in the lecture.					
12	Further Information: None.					

Module MD 4: Data Science in Practice																				
Degree program: Master Data Science																				
Interval: annual	Duration: 2 semester	Study phase:		CP 6	Workload 180h															
		Winter start 1 st semester	Summer start 1 st to 2 nd semester																	
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Data Science in Context</td><td>L</td><td>3</td><td>2</td></tr><tr><td>2</td><td>Advanced Programming Course</td><td>P</td><td>3</td><td>2</td></tr></table>					No.	Element / course	Type	CP	Weekly contact hours	1	Data Science in Context	L	3	2	2	Advanced Programming Course	P	3	2
No.	Element / course	Type	CP	Weekly contact hours																
1	Data Science in Context	L	3	2																
2	Advanced Programming Course	P	3	2																
2	Language of instruction: No. 1: English, No. 2: English. By arrangement, courses taught in German are possible.																			
3	Teaching content: No. 1: The course Data Science in Context covers varying topics related to the application of data science in academia and industry. Usually, several internal and external speakers are invited for this purpose to talk about the applications of data science. Additionally, the course covers basics of research data management and good scientific practice. No. 2: The students participate in a software or programming language course , e.g., SAS, Julia, R or Python, which they have not chosen in another module. Students are explicitly encouraged to attend an advanced course that deepens their knowledge of an already known programming language.																			
4	Competencies: The students gain specialized knowledge on a software package or a programming language and apply methods from statistics and data analysis to real data using their own program code. They adopt unknown computation techniques. The students know the important aspects of their profession. Students are able to solve complex visualization tasks. To do this, they combine methods that are available in existing systems in an in an engineering-like manner and apply these.																			
5	Examinations: Two accumulated graded exams.																			
6	Types of examinations and performances: Exams as announced by the lecturers.																			
7	Recommended knowledge: None.																			
8	Formal requirements: None.																			
9	Module type and applicability of the module: Compulsory module in Master Data Science.																			
10	Module coordinator: Prof. Dr. P Bürkner (No. 1, No. 2), Dr. A. Bommert (No. 2)			Responsible department: Department of Statistics																
11	Literature: Will be announced in the lecture.																			
12	Further Information: None.																			

Module MD 5: Project Work																														
Degree program: Master Data Science																														
Interval: Each semester, as offered	Duration: 1 semester	Study phase:		CP 12	Workload 360h																									
		Winter start 3 rd semester	Summer start 3 rd semester																											
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1a</td><td>Advanced Case Studies</td><td>P</td><td>8</td><td>4</td></tr><tr><td>1b</td><td>Data Analysis Contest</td><td>P</td><td>8</td><td>4</td></tr><tr><td>1c</td><td>External Internship</td><td>P</td><td>8</td><td></td></tr><tr><td>2</td><td>Seminar</td><td>S</td><td>4</td><td>2</td></tr></table>					No.	Element / course	Type	CP	Weekly contact hours	1a	Advanced Case Studies	P	8	4	1b	Data Analysis Contest	P	8	4	1c	External Internship	P	8		2	Seminar	S	4	2
No.	Element / course	Type	CP	Weekly contact hours																										
1a	Advanced Case Studies	P	8	4																										
1b	Data Analysis Contest	P	8	4																										
1c	External Internship	P	8																											
2	Seminar	S	4	2																										
2	Language of instruction: No. 1a - c: English (at least once per year). Courses taught in German are possible, No. 2: English. Courses taught in German are possible.																													
3	Teaching content: For No. 1, the students choose between internal and external exercises in preparation for professional work. In the “ Case Studies ” course, the students work on one or two extensive projects dealing with real data applications. They work independently to a large extent, collaborating in teams. They choose, adopt knowledge on, and adjust methods of statistics and data analysis for the given problem. They write reports and make presentations on the methodology and their conducted extensive data analysis. They practice interactions with other fields of science and application. By arrangement, Case Studies can be replaced by a Data Analysis Contest . Respective courses will be marked in the lecture table. During the external internship, the students work at a company or institution related to their field of study. They participate in professional working groups conducting real data analyses. They report their project and results. More information on external internship can be found here: https://statistik.tu-dortmund.de/en/studies/internships/ . In the Seminar , every student reads a scientific paper, critically reflecting its contents. The main results of this work are presented in a talk and reported in written form.																													
4	Competencies: The students work independently on a given problem, collaborating in teams. They adopt previously unknown methods and adapt them to real data tasks. They interact with co-workers from the same and other fields, advise practitioners, transfer tasks in terms of mathematics and rephrase results accordingly. They present results in written and oral form. They conduct and finish projects within a given period of time. The students adopt knowledge on a special field of data science and comprehend and reflect the scientific work of others. They understand a new subject and explain its methods and results in class. They give critical feedback on other talks.																													
5	Examinations: Two accumulated graded exams.																													
6	Types of examinations and performances: Attendance may be mandatory for the courses in this module. If applicable, this will be announced at the beginning of the course. The module examination consists of written assignments and presentations.																													
7	Recommended knowledge: none.																													
8	Formal requirements: If there are stipulates in case of conditional admission (any of module's MD Stip-1 to MD Stip-4), these have to be fulfilled by the start of the course Case Studies, the Data Analysis Contest or the external internship.																													
9	Module type and applicability of the module: Compulsory module in Master Data Science.																													
10	Module coordinator: Chairperson of examination board		Responsible department: Department of Statistics Department of Computer Science Department of Mathematics																											
11	Literature: Will be announced in the lecture.																													
12	Further Information: None.																													

Module MD 9: Master Thesis																				
Degree program: Master Data Science																				
Interval: Each semester	Duration: 1 semester	Study phase:		CP 30	Workload 900h															
		Winter start 4 th semester	Summer start 4 th semester																	
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Master Thesis</td><td></td><td>27</td><td></td></tr><tr><td>2</td><td>Advanced Seminar ("Oberseminar")</td><td>S</td><td>3</td><td>2</td></tr></table>					No.	Element / course	Type	CP	Weekly contact hours	1	Master Thesis		27		2	Advanced Seminar ("Oberseminar")	S	3	2
No.	Element / course	Type	CP	Weekly contact hours																
1	Master Thesis		27																	
2	Advanced Seminar ("Oberseminar")	S	3	2																
2	Language of instruction: English. By arrangement, courses taught in German are possible.																			
3	Teaching content: The Master Thesis proves the student's ability to apply and adapt scientific methods to a problem of data science and related fields within a period of six months. Students may choose between several proposed subjects or introduce their own. The thesis can also be written at - or on collaboration with - an external public or private institution. In a special seminar, the student gives a talk to discuss the thesis' results followed by a disputation. This may be replaced by an external talk, e.g., at a company or scientific conference, in the presence of the supervisor.																			
4	Competencies: The students independently adopt knowledge on a new subject, conduct studies, and adapt and reflect methods. They communicate the project, methods and results in a well-structured manner and discuss them critically. They compactly present and discuss their own work. They design their project independently, together with the supervisor and perhaps an external partner, and finish it within a given period of time.																			
5	Examinations: Master Thesis.																			
6	Types of examinations and performances: Successful pass of thesis. Course achievement prior to submission of the thesis: presentation in the Advanced Seminar ("Oberseminar").																			
7	Recommended knowledge: none.																			
8	Formal requirements: At least 50 credit points, including 9 credit points for Module MD 1 Statistical Theory, and successfully completed at least the sub-performance "Case Studies" from MD 5 Project work.																			
9	Module type and applicability of the module: Compulsory module in Master Data Science.																			
10	Module coordinator: Chairperson of the Examination Board		Responsible department: Department of Statistics Department of Computer Science Department of Mathematics																	
11	Literature: Will be announced in the lecture.																			
12	Further Information: None.																			

Elective Fields

Elective field MD 6 Advanced Machine Learning

In the elective area "Advanced Machine Learning", students acquire in-depth methodological and practical competencies in current machine learning approaches. They develop the ability to understand, implement, and critically evaluate advanced algorithms for complex data and tasks. The area covers a broad spectrum of modern machine learning paradigms, including deep learning, causality, reinforcement learning, and natural language processing. Students gain experience in selecting and adapting appropriate models to specific application contexts. Through theoretical foundations and hands-on projects, they are prepared to apply state-of-the-art techniques in research and real-world scenarios.

Students may choose either two basis modules worth 9 ECTS each; or one basis module worth 9 ECTS plus two specialized modules worth 4.5 ECTS each; or four specialized modules worth 4.5 ECTS each.

Suitable courses will be clearly indicated in the course catalogue. A document showing the history of past courses in the elective field is available on the department's website.

When registering for exams, it must be ensured that each chosen course is unambiguously assigned to one of the modules. The two basic modules each comprise 9 credit points, while the four advanced modules each comprise 4.5 credit points.

In case of failing a course, the following special regulations apply:

- It is possible to switch courses freely within a module.
- Each module (not each course!) allows for three examination attempts.
- If a module is definitively failed, examination attempts in the remaining modules may still be undertaken.
- Examination formats within a chosen module must be consistent. For example, if a course in Module 1 is completed with a written exam and the exam is not passed, the retake exam for Module 1 should also be a written exam. It does not matter whether the retake takes place in the same course or in a different, newly chosen course.

Examples:

1. Course X was taken in Module 1 and failed. Subsequently, Course Y is taken and passed in Module 1. Thus, Course Y is recorded for the final certificate for Module 1. It remains possible to take Course A in Module 2, where three new examination attempts are available.
2. Course X was taken three times in Module 1 and failed all three attempts. It is still possible to take course X in Module 2 and attempt the exam three more times. However, we do not recommend to do so, after three failed attempts it might be time for you to try a different course.
3. Three failed attempts were made in module 1. Module 1 is therefore definitively failed. In this case, it is no longer possible to complete the elective area by taking two modules worth 9 ECTS, since only one module with 9 ECTS remains (module 2). However, it remains possible to complete the elective area by passing module 2 (9 ECTS) and two of the modules 3 to 6 (each with 4.5 ECTS).

Module MD 6-1: Basis Module Advanced Machine Learning 1																				
Degree program: Master Data Science																				
Interval: As offered		Duration: 1 semester	Study phase:		CP 9	Workload 270h														
			Summer start 2 nd to 3 rd semester	Winter start 1 st to 2 nd semester																
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Lecture</td><td>L</td><td>6</td><td>4</td></tr><tr><td>2</td><td>Tutorial</td><td>T</td><td>3</td><td>2</td></tr></table>					No.	Element / course	Type	CP	Weekly contact hours	1	Lecture	L	6	4	2	Tutorial	T	3	2
No.	Element / course	Type	CP	Weekly contact hours																
1	Lecture	L	6	4																
2	Tutorial	T	3	2																
2	Language of instruction: English or German, by arrangement.																			
3	Teaching content: In the elective area "Advanced Machine Learning", students acquire in-depth methodological and practical competencies in current machine learning approaches. They develop the ability to understand, implement, and critically evaluate advanced algorithms for complex data and tasks. The area covers a broad spectrum of modern machine learning paradigms, including deep learning, causality, reinforcement learning, and natural language processing. Students gain experience in selecting and adapting appropriate models to specific application contexts. Through theoretical foundations and hands-on projects, they are prepared to apply state-of-the-art techniques in research and real-world scenarios.																			
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.																			
5	Examinations: Graded exams.																			
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.																			
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.																			
8	Formal requirements: None.																			
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.																			
10	Module coordinator: Head of examination board			Responsible department: Department of Computer Science																
11	Literature: Will be announced in the lecture.																			
12	Further Information: None.																			

Module MD 6-2: Basis Module Advanced Machine Learning 2							
Degree program: Master Data Science							
Interval: As offered		Duration: 1 semester		Study phase:		CP 9	Workload 270h
				Winter start 2 nd to 3 rd semester			
1	Module structure:						
	No.	Element / course			Type	CP	Weekly contact hours
	1	Lecture			L	6	4
	2	Tutorial			T	3	2
2	Language of instruction: English or German, by arrangement.						
3	Teaching content: In the elective area "Advanced Machine Learning", students acquire in-depth methodological and practical competencies in current machine learning approaches. They develop the ability to understand, implement, and critically evaluate advanced algorithms for complex data and tasks. The area covers a broad spectrum of modern machine learning paradigms, including deep learning, causality, reinforcement learning, and natural language processing. Students gain experience in selecting and adapting appropriate models to specific application contexts. Through theoretical foundations and hands-on projects, they are prepared to apply state-of-the-art techniques in research and real-world scenarios.						
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.						
5	Examinations: Graded exams.						
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.						
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.						
8	Formal requirements: None.						
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.						
10	Module coordinator: Head of examination board				Responsible department: Department of Computer Science		
11	Literature: Will be announced in the lecture.						
12	Further Information: None.						

Module MD 6-3: Specialized Module Advanced Machine Learning 1						
Degree program: Master Data Science						
Interval: As offered		Duration: 1 semester	Study phase:		CP 4.5	Workload 270h
			Winter start 2 nd to 3 rd semester	Summer start 1 st to 2 nd semester		
1	Module structure:					
	No.	Element / course	Type	CP	Weekly contact hours	
	1	Lecture	L	3	2	
	2	Tutorial	T	1.5	1	
2	Language of instruction: English or German, by arrangement.					
3	Teaching content: In the elective area "Advanced Machine Learning", students acquire in-depth methodological and practical competencies in current machine learning approaches. They develop the ability to understand, implement, and critically evaluate advanced algorithms for complex data and tasks. The area covers a broad spectrum of modern machine learning paradigms, including deep learning, causality, reinforcement learning, and natural language processing. Students gain experience in selecting and adapting appropriate models to specific application contexts. Through theoretical foundations and hands-on projects, they are prepared to apply state-of-the-art techniques in research and real-world scenarios.					
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.					
5	Examinations: Graded exams.					
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.					
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.					
8	Formal requirements: None.					
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.					
10	Module coordinator: Head of examination board			Responsible department: Department of Computer Science		
11	Literature: Will be announced in the lecture.					
12	Further Information: None.					

Module MD 6-4: Specialized Module Advanced Machine Learning 2																				
Degree program: Master Data Science																				
Interval: As offered	Duration: 1 semester	Study phase:		CP 4.5	Workload 270h															
		Summer start 2 nd to 3 rd semester	Winter start 1 st to 2 nd semester																	
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Lecture</td><td>L</td><td>3</td><td>2</td></tr><tr><td>2</td><td>Tutorial</td><td>T</td><td>1.5</td><td>1</td></tr></table>					No.	Element / course	Type	CP	Weekly contact hours	1	Lecture	L	3	2	2	Tutorial	T	1.5	1
No.	Element / course	Type	CP	Weekly contact hours																
1	Lecture	L	3	2																
2	Tutorial	T	1.5	1																
2	Language of instruction: English or German, by arrangement.																			
3	Teaching content: In the elective area "Advanced Machine Learning", students acquire in-depth methodological and practical competencies in current machine learning approaches. They develop the ability to understand, implement, and critically evaluate advanced algorithms for complex data and tasks. The area covers a broad spectrum of modern machine learning paradigms, including deep learning, causality, reinforcement learning, and natural language processing. Students gain experience in selecting and adapting appropriate models to specific application contexts. Through theoretical foundations and hands-on projects, they are prepared to apply state-of-the-art techniques in research and real-world scenarios.																			
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.																			
5	Examinations: Graded exams.																			
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.																			
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.																			
8	Formal requirements: None.																			
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.																			
10	Module coordinator: Head of examination board		Responsible department: Department of Computer Science																	
11	Literature: Will be announced in the lecture.																			
12	Further Information: None.																			

Module MD 6-5: Specialized Module Advanced Machine Learning 3					
Degree program: Master Data Science					
Interval: As offered	Duration: 1 semester	Study phase:		CP 4.5	Workload 270h
		Summer start 2 nd to 3 rd semester	Winter start 1 st to 2 nd semester		
1	Module structure:				
	No.	Element / course	Type	CP	Weekly contact hours
	1	Lecture	L	3	2
	2	Tutorial	T	1.5	1
2	Language of instruction: English or German, by arrangement.				
3	Teaching content: In the elective area "Advanced Machine Learning", students acquire in-depth methodological and practical competencies in current machine learning approaches. They develop the ability to understand, implement, and critically evaluate advanced algorithms for complex data and tasks. The area covers a broad spectrum of modern machine learning paradigms, including deep learning, causality, reinforcement learning, and natural language processing. Students gain experience in selecting and adapting appropriate models to specific application contexts. Through theoretical foundations and hands-on projects, they are prepared to apply state-of-the-art techniques in research and real-world scenarios.				
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.				
5	Examinations: Graded exams.				
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.				
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.				
8	Formal requirements: None.				
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.				
10	Module coordinator: Head of examination board		Responsible department: Department of Computer Science		
11	Literature: Will be announced in the lecture.				
12	Further Information: None.				

Module MD 6-6: Specialized Module Advanced Machine Learning 4					
Degree program: Master Data Science					
Interval: As offered	Duration: 1 semester	Study phase:		CP 4.5	Workload 270h
		Summer start 2 nd to 3 rd semester	Summer start 2 nd to 3 rd semester		
1	Module structure:				
	No.	Element / course	Type	CP	Weekly contact hours
	1	Lecture	L	3	2
	2	Tutorial	T	1.5	1
2	Language of instruction: English or German, by arrangement.				
3	Teaching content: In the elective area "Advanced Machine Learning", students acquire in-depth methodological and practical competencies in current machine learning approaches. They develop the ability to understand, implement, and critically evaluate advanced algorithms for complex data and tasks. The area covers a broad spectrum of modern machine learning paradigms, including deep learning, causality, reinforcement learning, and natural language processing. Students gain experience in selecting and adapting appropriate models to specific application contexts. Through theoretical foundations and hands-on projects, they are prepared to apply state-of-the-art techniques in research and real-world scenarios.				
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.				
5	Examinations: Graded exams				
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.				
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.				
8	Formal requirements: None.				
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.				
10	Module coordinator: Head of examination board		Responsible department: Department of Computer Science		
11	Literature: Will be announced in the lecture.				
12	Further Information: None.				

Elective field MD 7 Applied Data Science

In the elective area Applied Data Science, students build upon the fundamental knowledge acquired during the Bachelor's degree. Possible subject areas include, in particular:

- Methods not primarily based on the linear model
(Nonparametric methods, robust methods, advanced Bayesian methods, sequential methods, extreme value statistics, ...)
- Methods based on the linear model
(Special regression techniques, variance component models, special analysis of variance techniques, models with errors in variables, models with qualitative variables, advanced generalized linear models, multivariate methods, discriminant and cluster analysis, Bayesian linear models, ...)
- Fields of application in statistics
(Analysis of statistical experiments, special sampling theory methods, special methods of experimental design, risk analysis, ...)
- Application areas particularly suitable for minors from the corresponding disciplines:
Life Sciences and Medicine
(Statistical methods in clinical trials, statistical methods in epidemiology, statistical methods in genetics)

Natural and Engineering Sciences
(Quality assurance, reliability and material fatigue, ...)

Psychology and Social Sciences
(Population statistics, demography, psychometrics, ...)

Economics
(Econometrics, official statistics, ...)

Students may choose either the module 1 worth 9 ECTS; or the modules 2 and 3 worth 4.5 ECTS each.

Suitable courses will be clearly indicated in the course catalogue. A document showing the history of past courses in the elective field is available on the department's website.

When registering for exams, it must be ensured that each chosen course is unambiguously assigned to one of the modules.

In case of failing a course, the following special regulations apply:

- It is possible to switch courses freely within a module.
- Each module (not each course!) allows for three examination attempts.
- If a module is definitively failed, examination attempts in the remaining modules may still be undertaken.
- Examination formats within a chosen module must be consistent. For example, if a course in Module 1 is completed with a written exam and the exam is not passed, the retake exam for Module 1 should also be a written exam. It does not matter whether the retake takes place in the same course or in a different, newly chosen course.

Examples:

1. Course X was taken in module 2 and failed. Subsequently, Course Y is taken and passed in this module. Thus, Course Y is recorded for the final certificate for this module 2. It remains possible to take Course X in the module 3, where three new examination attempts are available.
2. Three failed attempts were made in Module 1. Module 1 is therefore definitively failed. It remains possible to complete the elective area by passing modules 2 and 3.

Module MD 7-1: Applied Data Science 1							
Degree program: Master Data Science							
Interval: As offered		Duration: 1 semester		Study phase:		CP 9	Workload 270h
				Winter start 1 st semester			
1	Module structure:						
	No.	Element / course			Type	CP	Weekly contact hours
	1	Lecture			L	6	4
	2	Tutorial			T	3	2
2	Language of instruction: English or German, by arrangement.						
3	Teaching content: • Methods not primarily based on the linear model (Nonparametric methods, robust methods, advanced Bayesian methods, sequential methods, extreme value statistics, ...) • Methods based on the linear model (Special regression techniques, variance component models, special analysis of variance techniques, models with errors in variables, models with qualitative variables, advanced generalized linear models, multivariate methods, discriminant and cluster analysis, Bayesian linear models, ...) • Fields of application in statistics (Analysis of statistical experiments, special sampling theory methods, special methods of experimental design, risk analysis, ...) • Application areas particularly suitable for minors from the corresponding disciplines: <i>Life Sciences and Medicine</i> (Statistical methods in clinical trials, statistical methods in epidemiology, statistical methods in genetics) <i>Natural and Engineering Sciences</i> (Quality assurance, reliability and material fatigue, ...) <i>Psychology and Social Sciences</i> (Population statistics, demography, psychometrics, ...) <i>Economics</i> (Econometrics, official statistics, ...)						
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.						
5	Examinations: Graded exams.						
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.						
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.						
8	Formal requirements: None.						
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.						
10	Module coordinator: Head of examination board				Responsible department: Department of Statistics		
11	Literature: Will be announced in the lecture.						
12	Further Information: None.						

Module MD 7-2: Applied Data Science 2							
Degree program: Master Data Science							
Interval: As offered		Duration: 1 semester		Study phase:		CP 4.5	Workload 270h
				Winter start 1 st semester	Summer start 1 st semester		
1	Module structure:						
	No.	Element / course			Type	CP	Weekly contact hours
	1	Lecture			L	3	2
	2	Tutorial			T	1.5	1
2	Language of instruction: English or German, by arrangement.						
3	Teaching content: • Methods not primarily based on the linear model (Nonparametric methods, robust methods, advanced Bayesian methods, sequential methods, extreme value statistics, ...) • Methods based on the linear model (Special regression techniques, variance component models, special analysis of variance techniques, models with errors in variables, models with qualitative variables, advanced generalized linear models, multivariate methods, discriminant and cluster analysis, Bayesian linear models, ...) • Fields of application in statistics (Analysis of statistical experiments, special sampling theory methods, special methods of experimental design, risk analysis, ...) • Application areas particularly suitable for minors from the corresponding disciplines: <i>Life Sciences and Medicine</i> (Statistical methods in clinical trials, statistical methods in epidemiology, statistical methods in genetics) <i>Natural and Engineering Sciences</i> (Quality assurance, reliability and material fatigue, ...) <i>Psychology and Social Sciences</i> (Population statistics, demography, psychometrics, ...) <i>Economics</i> (Econometrics, official statistics, ...)						
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.						
5	Examinations: Graded exams.						
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.						
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.						
8	Formal requirements: None.						
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.						
10	Module coordinator: Head of examination board					Responsible department: Department of Statistics	
11	Literature: Will be announced in the lecture.						
12	Further Information: None.						

Module MD 7-3: Applied Data Science 3						
Degree program: Master Data Science						
Interval: As offered		Duration: 1 semester	Study phase:		CP 4.5	Workload 270h
			Winter start 1 st semester	Summer Start 1 st semester		
1	Module structure:					
	No.	Element / course	Type	CP	Weekly contact hours	
	1	Lecture	L	3	2	
	2	Tutorial	T	1.5	1	
2	Language of instruction: English or German, by arrangement.					
3	Teaching content: • Methods not primarily based on the linear model (Nonparametric methods, robust methods, advanced Bayesian methods, sequential methods, extreme value statistics, ...) • Methods based on the linear model (Special regression techniques, variance component models, special analysis of variance techniques, models with errors in variables, models with qualitative variables, advanced generalized linear models, multivariate methods, discriminant and cluster analysis, Bayesian linear models, ...) • Fields of application in statistics (Analysis of statistical experiments, special sampling theory methods, special methods of experimental design, risk analysis, ...) • Application areas particularly suitable for minors from the corresponding disciplines: <i>Life Sciences and Medicine</i> (Statistical methods in clinical trials, statistical methods in epidemiology, statistical methods in genetics) <i>Natural and Engineering Sciences</i> (Quality assurance, reliability and material fatigue, ...) <i>Psychology and Social Sciences</i> (Population statistics, demography, psychometrics, ...) <i>Economics</i> (Econometrics, official statistics, ...)					
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.					
5	Examinations: Graded exams.					
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.					
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.					
8	Formal requirements: None.					
9	Module type and applicability of the module: Elective module in Master Data Science in the field Advanced Machine Learning.					
10	Module coordinator: Head of examination board			Responsible department: Department of Statistics		
11	Literature: Will be announced in the lecture.					
12	Further Information: None.					

Elective field MD 8 Methodical Data Science

The modules in the elective field Methodical Data Science are intended to deepen the knowledge already acquired during the Master's program. In addition to the application areas listed under the module Applied Statistics, possible topics include, in particular, those related to temporal and spatio-temporal statistics (e.g., music data analysis, panel data analysis, ...), as well as subfields of statistics whose methodology builds on the content of module MD 1.

In addition, to subjects from the field of statistics, students may choose to deepen their knowledge in specialized mathematical courses, especially from the field's optimization and numerical mathematics.

Students may choose either two modules worth 9 ECTS each; or one module worth 9 ECTS plus two modules worth 4.5 ECTS each; or four modules worth 4.5 ECTS each.

Suitable courses will be clearly indicated in the course catalogue. A document showing the history of past courses in the elective field is available on the department's website.

When registering for exams, it must be ensured that each chosen course is unambiguously assigned to one of the modules.

In case of failing a course, the following special regulations apply:

- It is possible to switch courses freely within a module.
- Each module (not each course!) allows for three examination attempts.
- If a module is definitively failed, examination attempts in the remaining modules may still be undertaken.
- Examination formats within a chosen module must be consistent. For example, if a course in Module 1 is completed with a written exam and the exam is not passed, the retake exam for Module 1 should also be a written exam. It does not matter whether the retake takes place in the same course or in a different, newly chosen course.

Examples:

1. Course X was taken in Module 1 and failed. Subsequently, Course Y is taken and passed in Module 1. Thus, Course Y is recorded for the final certificate for Module 1. It remains possible to take Course A in Module 2, where three new examination attempts are available.
2. Course X was taken three times in Module 1 and failed all three attempts. It is still possible to take course X in Module 2 and attempt the exam three more times. However, we do not recommend to do so, after three failed attempts it might be time for you to try a different course.
3. Three failed attempts were made in module 1. Module 1 is therefore definitively failed. In this case, it is no longer possible to complete the elective area by taking two modules worth 9 ECTS, since only one module with 9 ECTS remains (module 2). However, it remains possible to complete the elective area by passing module 2 (9 ECTS) and two of the modules 3 to 6 (each with 4.5 ECTS).

Module MD 8-1: Methodical Data Science 1						
Degree program: Master Data Science						
Interval: As offered		Duration: 1 semester	Study phase:		CP 9	Workload 270h
			Winter start 2 nd to 3 rd semester	Summer start 2 nd to 3 rd semester		
1	Module structure:					
	No.	Element / course	Type	CP	Weekly contact hours	
	1	Lecture	L	6	4	
	2	Tutorial	T	3	2	
2	Language of instruction: English or German, by arrangement.					
3	Teaching content: The modules in the elective field Methodical Data Science are intended to deepen the knowledge already acquired during the Master's program. In addition to the application areas listed under the module Applied Statistics, possible topics include, in particular, those related to temporal and spatio-temporal statistics (e.g., music data analysis, panel data analysis, ...), as well as subfields of statistics whose methodology builds on the content of module MD 1. In addition, to subjects from the field of statistics, students may choose to deepen their knowledge in specialized mathematical courses, especially from the field's optimization and numerical mathematics.					
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.					
5	Examinations: Graded exams.					
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.					
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.					
8	Formal requirements: None.					
9	Module type and applicability of the module: Elective module in Master Data Science in the field Methodical Data Science.					
10	Module coordinator: Head of examination board			Responsible department: Department of Statistics, Department of Mathematics		
11	Literature: Will be announced in the lecture.					
12	Further Information: None.					

Module MD 8-2: Methodical Data Science 2																						
Degree program: Master Data Science																						
Interval: As offered		Duration: 1 semester		Study phase:		CP 9	Workload 270h															
				Winter start 2 nd to 3 rd semester				Summer start 2 nd to 3 rd semester														
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Lecture</td><td>L</td><td>6</td><td>4</td></tr><tr><td>2</td><td>Tutorial</td><td>T</td><td>3</td><td>2</td></tr></table>							No.	Element / course	Type	CP	Weekly contact hours	1	Lecture	L	6	4	2	Tutorial	T	3	2
No.	Element / course	Type	CP	Weekly contact hours																		
1	Lecture	L	6	4																		
2	Tutorial	T	3	2																		
2	Language of instruction: English or German, by arrangement.																					
3	Teaching content: The modules in the elective field Methodical Data Science are intended to deepen the knowledge already acquired during the Master's program. In addition to the application areas listed under the module Applied Statistics, possible topics include, in particular, those related to temporal and spatio-temporal statistics (e.g., music data analysis, panel data analysis, ...), as well as subfields of statistics whose methodology builds on the content of module MD 1. In addition, to subjects from the field of statistics, students may choose to deepen their knowledge in specialized mathematical courses, especially from the field's optimization and numerical mathematics.																					
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.																					
5	Examinations: Graded exams.																					
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.																					
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.																					
8	Formal requirements: None.																					
9	Module type and applicability of the module: Elective module in Master Data Science in the field Methodical Data Science.																					
10	Module coordinator: Head of examination board				Responsible department: Department of Statistics, Department of Mathematics																	
11	Literature: Will be announced in the lecture.																					
12	Further Information: None.																					

Module MD 8-3: Methodical Data Science 3																						
Degree program: Master Data Science																						
Interval: As offered		Duration: 1 semester		Study phase:		CP 4.5	Workload 135h															
				Winter start 2 nd to 3 rd semester				Summer start 2 nd to 3 rd semester														
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Lecture</td><td>L</td><td>3</td><td>2</td></tr><tr><td>2</td><td>Tutorial</td><td>T</td><td>1.5</td><td>1</td></tr></table>							No.	Element / course	Type	CP	Weekly contact hours	1	Lecture	L	3	2	2	Tutorial	T	1.5	1
No.	Element / course	Type	CP	Weekly contact hours																		
1	Lecture	L	3	2																		
2	Tutorial	T	1.5	1																		
2	Language of instruction: English or German, by arrangement.																					
3	Teaching content: The modules in the elective field Methodical Data Science are intended to deepen the knowledge already acquired during the Master's program. In addition to the application areas listed under the module Applied Statistics, possible topics include, in particular, those related to temporal and spatio-temporal statistics (e.g., music data analysis, panel data analysis, ...), as well as subfields of statistics whose methodology builds on the content of module MD 1. In addition, to subjects from the field of statistics, students may choose to deepen their knowledge in specialized mathematical courses, especially from the field's optimization and numerical mathematics.																					
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.																					
5	Examinations: Graded exams.																					
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.																					
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.																					
8	Formal requirements: None.																					
9	Module type and applicability of the module: Elective module in Master Data Science in the field Methodical Data Science.																					
10	Module coordinator: Head of examination board				Responsible department: Department of Statistics, Department of Mathematics																	
11	Literature: Will be announced in the lecture.																					
12	Further Information: None.																					

Module MD 8-4: Methodical Data Science 4																						
Degree program: Master Data Science																						
Interval: As offered		Duration: 1 semester		Study phase:		CP 4.5	Workload 135h															
				Winter start 2 nd to 3 rd semester				Summer start 2 nd to 3 rd semester														
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Lecture</td><td>L</td><td>3</td><td>2</td></tr><tr><td>2</td><td>Tutorial</td><td>T</td><td>1.5</td><td>1</td></tr></table>							No.	Element / course	Type	CP	Weekly contact hours	1	Lecture	L	3	2	2	Tutorial	T	1.5	1
No.	Element / course	Type	CP	Weekly contact hours																		
1	Lecture	L	3	2																		
2	Tutorial	T	1.5	1																		
2	Language of instruction: English or German, by arrangement.																					
3	Teaching content: The modules in the elective field Methodical Data Science are intended to deepen the knowledge already acquired during the Master's program. In addition to the application areas listed under the module Applied Statistics, possible topics include, in particular, those related to temporal and spatio-temporal statistics (e.g., music data analysis, panel data analysis, ...), as well as subfields of statistics whose methodology builds on the content of module MD 1. In addition, to subjects from the field of statistics, students may choose to deepen their knowledge in specialized mathematical courses, especially from the field's optimization and numerical mathematics.																					
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.																					
5	Examinations: Graded exams.																					
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.																					
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.																					
8	Formal requirements: None.																					
9	Module type and applicability of the module: Elective module in Master Data Science in the field Methodical Data Science.																					
10	Module coordinator: Head of examination board				Responsible department: Department of Statistics, Department of Mathematics																	
11	Literature: Will be announced in the lecture.																					
12	Further Information: None.																					

Module MD 8-5: Methodical Data Science 5																						
Degree program: Master Data Science																						
Interval: As offered		Duration: 1 semester		Study phase:		CP 4.5	Workload 135h															
				Winter start 2 nd to 3 rd semester				Summer start 2 nd to 3 rd semester														
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Lecture</td><td>L</td><td>3</td><td>2</td></tr><tr><td>2</td><td>Tutorial</td><td>T</td><td>1.5</td><td>1</td></tr></table>							No.	Element / course	Type	CP	Weekly contact hours	1	Lecture	L	3	2	2	Tutorial	T	1.5	1
No.	Element / course	Type	CP	Weekly contact hours																		
1	Lecture	L	3	2																		
2	Tutorial	T	1.5	1																		
2	Language of instruction: English or German, by arrangement.																					
3	Teaching content: The modules in the elective field Methodical Data Science are intended to deepen the knowledge already acquired during the Master's program. In addition to the application areas listed under the module Applied Statistics, possible topics include, in particular, those related to temporal and spatio-temporal statistics (e.g., music data analysis, panel data analysis, ...), as well as subfields of statistics whose methodology builds on the content of module MD 1. In addition, to subjects from the field of statistics, students may choose to deepen their knowledge in specialized mathematical courses, especially from the field's optimization and numerical mathematics.																					
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.																					
5	Examinations: Graded exams.																					
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.																					
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.																					
8	Formal requirements: None.																					
9	Module type and applicability of the module: Elective module in Master Data Science in the field Methodical Data Science.																					
10	Module coordinator: Head of examination board				Responsible department: Department of Statistics, Department of Mathematics																	
11	Literature: Will be announced in the lecture.																					
12	Further Information: None.																					

Module MD 8-6: Methodical Data Science 6																				
Degree program: Master Data Science																				
Interval: As offered	Duration: 1 semester	Study phase:		CP 4.5	Workload 135h															
		Winter start 2 nd to 3 rd semester	Summer start 2 nd to 3 rd semester																	
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Lecture</td><td>L</td><td>3</td><td>2</td></tr><tr><td>2</td><td>Tutorial</td><td>T</td><td>1.5</td><td>1</td></tr></table>					No.	Element / course	Type	CP	Weekly contact hours	1	Lecture	L	3	2	2	Tutorial	T	1.5	1
No.	Element / course	Type	CP	Weekly contact hours																
1	Lecture	L	3	2																
2	Tutorial	T	1.5	1																
2	Language of instruction: English or German, by arrangement.																			
3	Teaching content: The modules in the elective field Methodical Data Science are intended to deepen the knowledge already acquired during the Master's program. In addition to the application areas listed under the module Applied Statistics, possible topics include, in particular, those related to temporal and spatio-temporal statistics (e.g., music data analysis, panel data analysis, ...), as well as subfields of statistics whose methodology builds on the content of module MD 1. In addition, to subjects from the field of statistics, students may choose to deepen their knowledge in specialized mathematical courses, especially from the field's optimization and numerical mathematics.																			
4	Competencies: Students acquire in-depth and comprehensive knowledge of machine learning methods within a specific subfield of machine learning. They understand the theoretical background of the introduced methods and are able to apply them. For a given problem, they are capable of selecting an appropriate method from those presented.																			
5	Examinations: Graded exams																			
6	Types of examinations and performances: The type of examination and assessment will be announced by the instructors at the beginning of the respective course.																			
7	Recommended knowledge: Basics in Mathematics, Statistics and Computer Science.																			
8	Formal requirements: None.																			
9	Module type and applicability of the module: Elective module in Master Data Science in the field Methodical Data Science.																			
10	Module coordinator: Head of examination board		Responsible department: Department of Statistics, Department of Mathematics																	
11	Literature: Will be announced in the lecture.																			
12	Further Information: None.																			

Stipulate courses

In case of admission, you might be admitted under the requirement to take some additional stipulate courses. You have to take courses as listed on your admission letter in addition to the regular 120 ECTS of the master program.

Module MD Stip-1: Probability						
Degree program: Master Data Science						
Interval: As offered		Duration: 1 semester	Study phase: beginning of program		CP 5	Workload 150h
1	Module structure:					
	No.	Element / course		Type	CP	Weekly contact hours
	1	Reading Course Probability		Reading Course	5	
2	Language of instruction: English					
3	Teaching content: • Concepts of probability, distributions, conditional probability and independence, Bayes' rule, sequences of events. • Sampling, Binomial distribution, Normal approximation, Poisson distribution. • Random variables, expectation and variance. • Probability densities, Exponential and Gamma distributions, substitutions, cumulative distribution functions. • Joint distributions, Uniform and Normal distributions. • Dependence, conditional distributions, covariance and correlation.					
4	Competencies: Students gain a deep understanding of probability. They independently integrate statistical problems in the context of probability theory and solve them using appropriate methods. Students apply mathematical proof techniques.					
5	Examinations: Module exam.					
6	Types of examinations and performances: Written Exam.					
7	Recommended knowledge: None.					
8	Formal requirements: None.					
9	Module type and applicability of the module: Possible requirement in case of conditional admission to the M. Sc. study program Data Science.					
10	Module coordinator: Prof. Dr. K. Ickstadt, Prof. Dr. C. Jentsch			Responsible department: Department of Statistics		
11	Literature: Jim Pitman: Probability. Springer 1993: Chapters 1, 2.1, 2.2, 2.5, 3.1-3.5, 4.1, 4.2, 4.4, 4.5, 5.1-5.3, 6.					
12	Further Information: None.					

Module MD Stip-2: Inference									
Degree program: Master Data Science									
Interval: As offered		Duration: 1 semester		Study phase: beginning of program		CP 5		Workload 150h	
1	Module structure:								
	No.	Element / course			Type	CP	Weekly contact hours		
	1	Reading Course Inference			Reading Course	5			
2	Language of instruction: English								
3	Teaching content:								
	- Parametric point estimation: method of moments and maximum likelihood; consistency; sufficiency; error, bias and loss; completeness; Rao-Cramer-bound; invariance; Bayesian estimation. - Parametric interval estimation: confidence intervals, especially for Normal distribution parameters, finding methods, Bayesian estimation. - Tests of hypotheses: simple and composite hypotheses, loss function, (uniformly) most powerful tests, unbiased tests, tests for (multivariate) Normal distribution parameters, Chi-square tests, relation to confidence intervals.								
4	Competencies: Students calculate point and interval estimators and carry out significance tests. They prove basic properties of estimators and tests. Students apply the methods to real data.								
5	Examinations: Module exam.								
6	Types of examinations and performances: Written Exam.								
7	Recommended knowledge: None.								
8	Formal requirements: None.								
9	Module type and applicability of the module: Possible requirement in case of conditional admission to the M. Sc. study program Data Science.								
10	Module coordinator: Prof. Dr. R. Fried, Prof. Dr. K. Schorning					Responsible department: Department of Statistics			
11	Literature: Alexander M. Mood, Franklin A. Graybill, Duane C. Boes: Introduction to the Theory of Statistics. McGraw-Hill 1974: Chapters VII, VIII, IX.1-IX.6.								
12	Further Information: None.								

Module MD Stip-3: Linear Models									
Degree program: Master Data Science									
Interval: As offered		Duration: 1 semester		Study phase: beginning of program		CP 5		Workload 150h	
1	Module structure:								
	No.	Element / course			Type	CP	Weekly contact hours		
	1	Reading Course Linear Models			Reading Course	5			
2	Language of instruction: English								
3	Teaching content:								
	• Introduction to regression models: real data examples, simple and multiple linear models, binary response models. • Linear model components: parameters, covariates, residuals, assumptions. • Parameter estimation: coefficients and error variance. • Hypothesis tests and confidence intervals: F-Tests, confidence regions, prediction intervals. • Model choice: variable selection, prediction evaluation, criteria.								
4	Competencies: Students calculate point and interval estimators and carry out significance tests in the context of the linear model. They have knowledge on model selection. Students apply the methods to real data.								
5	Examinations: Module exam.								
6	Types of examinations and performances: Written Exam.								
7	Recommended knowledge: None.								
8	Formal requirements: None.								
9	Module type and applicability of the module: Possible requirement in case of conditional admission to the M. Sc. study program Data Science.								
10	Module coordinator: Prof. Dr. A. Groll, Prof. Dr. K. Ickstadt, Dr. T. Ziebach				Responsible department: Department of Statistics				
11	Literature: Thomas Kneib, Stefan Lang, Ludwig Fahrmeir, Brian D. Marx: Regression: Models, Methods and Applications. Springer 2015: Chapters 1, 2.1-2.3, 3.								
12	Further Information: None.								

Module MD Stip-4: Introduction to Statistical Learning															
Degree program: Master Data Science															
Interval: As offered		Duration: 1 semester		Study phase: beginning of program											
		CP 5		Workload 150h											
1	Module structure: <table><tr><td>No.</td><td>Element / course</td><td>Type</td><td>CP</td><td>Weekly contact hours</td></tr><tr><td>1</td><td>Reading Course Introduction to Statistical Learning</td><td>Reading Course</td><td>5</td><td></td></tr></table>					No.	Element / course	Type	CP	Weekly contact hours	1	Reading Course Introduction to Statistical Learning	Reading Course	5	
No.	Element / course	Type	CP	Weekly contact hours											
1	Reading Course Introduction to Statistical Learning	Reading Course	5												
2	Language of instruction: English or German, by arrangement														
3	Teaching content: The course Introduction to Statistical Learning is an introduction to statistical and machine learning models. First, basic methods from the areas of data pre-processing and data understanding are presented. Next, depending on the target variable (continuous vs. discrete; observable vs. unobservable), four basic paradigms of methods are distinguished and presented: Regression, Classification, Clustering and Outlier methods. For each of these paradigms, different modelling concepts are presented, such as nearest neighbor methods, linear methods, trees, as well as probabilistic, ensemble or regularization methods. In addition, general model validation and model selection methods are presented for the different machine learning paradigms.														
4	Competencies: Students understand different models and analysis procedures. In realistic data situations, they can select suitable procedures and apply them with machine learning and statistical learning toolkits. They understand the underlying mathematical-statistical theory.														
5	Examinations: Module exam.														
6	Types of examinations and performances: Oral Exam.														
7	Recommended knowledge: None.														
8	Formal requirements: None.														
9	Module type and applicability of the module: Possible requirement in case of conditional admission to the M. Sc. study program Data Science.														
10	Module coordinator: Prof. Dr. A. Groll			Responsible department: Department of Statistics											
11	Literature: James, G., Witten, D., Hastie, T., & Tibshirani, R. (2013). An introduction to statistical learning, Chapters 1, 2.1-2.2, 3.1-3.2, 4.1-4.4, 5.1-5.2, 6.2, 8.1-8.2														
12	Further Information: None.														