Core Area: data science

degree programme	Data Science (M.Sc.)
Modules	Introduction to Machine Learning
Module number	DSM-DS-101

1	**Entry requirements**
Subject related semester	1st or 2nd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	P

2	**Profile**

Aims of the module/integration into the curriculum

Foundational course for the field of data science – aims to provide an orientation and overview of methods in machine learning (ML) and data science.
The modules aim to teach students the fundamental concepts, methods and algorithms of machine learning. Participants will not only learn the theoretical foundations, but also the practical implementation and evaluation of ML models, using Python as the primary programming language. To this end, a complete ML workflow is implemented alongside the course through example projects – from data preparation and

model training to the evaluation and interpretation of results.

content of teaching

The lecture introduces fundamental concepts and methods of machine learning. It begins with a systematic introduction to the main paradigms of the subject: supervised, unsupervised learning and reinforcement learning. There is a particular focus on supervised learning, covering key methods such as linear and logistic regression, as well as classification methods such as k-nearest neighbours, decision trees and support vector machines (SVM). Building on this, basic neural networks are introduced and initial applications of, for example, convolutional neural networks (CNNs) are presented.

In the area of unsupervised learning, methods of cluster analysis (such as K-means and hierarchical clustering) and dimensionality reduction (such as PCA and t-SNE) are taught. In addition, the course offers an introduction to time series analysis based on classical ARIMA models. A further focus is on the evaluation and optimisation of models using methods such as cross-validation and hyperparameter tuning (e.g. grid search).

In addition to methodological aspects, the lecture covers current developments in the field of explainable AI (e.g. LIME, SHAP) as well as fundamental ethical issues in machine learning, such as fairness, data bias and algorithmic accountability.

The accompanying tutorials reinforce the content through practical applications in typical ML workflows. The practical component of the course is largely

conducted in small groups and is supported by

weekly meetings that lead step-by-step to the implementation of a complete ML project.
Learning outcomes
Students … ... understand fundamental concepts and algorithms of machine learning, including regression, classification and neural networks. ... learn how to implement these concepts in practice using Python and associated libraries such as Scikit-Learn, TensorFlow and PyTorch. ... acquire practical skills in the implementation, evaluation and optimisation of machine learning models for various use cases. ... learn how to select, develop and apply machine learning methods in a targeted manner to effectively solve data-driven problems. ... are able to recognise the ethical challenges and implications of machine learning and can critically assess them. … systematically implement the typical steps of a complete machine learning workflow using Python and common libraries (e.g. Scikit-Learn, TensorFlow, PyTorch, Pandas). … interpret the results of their models and communicate them in a clear and transparent.

3	**Structure**					
Components of the module						
No.	Specification Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Introduction to Machine Learning	P	30 (2 contact hours per week)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials for "Introduction to Machine Learning"	P	30 (2 contact hours)	30
3	Practical	Practical	Internship in Interdisciplinary Machine Learning	P	30 (2 contact hours per week)	120
Options within the modules:						
None						

4	**Examination structure**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration / Scope Note	Organisational link to course no. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 30-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	90–120 min.	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework			
No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving exercises, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2
2	Working on practical assignments in groups	One continuous practical assignment per semester with a final report of 8–12 pages and a 10–15-minute presentation of the results.	3

5	**Allocation of workload**	
Participation (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1 credit
Coursework (and self-study)	SL No. 1	1 credit
	SL No. 2	4
Examination requirements (and self-study)	PL No. 1	2 credits
Total credits		10 credits

The workload of the module is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule		
Frequency		Every winter semester	
Person responsible for module		The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science Department 14 – Earth Sciences

8	Mobility/Recognition	
Applicability to other degree programmes		Computer Science (M.Sc.); Mathematics (M.Sc., with a specialisation in Computer Science); Mathematics (M.Sc.), Mathematics (BA), Geoinformatics and data science (M.Sc.); Geospatial Technologies (M.Sc.)
Module language(s)		English
Module title in English		Introduction to Machine Learning
English translation of the module components from field 3		Course No. 1: Introduction to Machine Learning
		Course No. 2: Recitation Sessions on "Introduction to ML"
		Course No. 3: Practical Course Recitation Sessions on "Interdisciplinary Introduction to Machine Learning"

9	Miscellaneous
	Admission to the examination is conditional upon the successful completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Data Engineering
Module number	DSM-DS-102

1	**Entry requirements**
Subject related semester	1st or 2nd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	P

2	**Profile**

Aims of the module/integration into the curriculum

Foundational course for the data science field – aims to provide a solid understanding of the data processing and infrastructure required for the use of Machine Learning (ML). The course offers a practical introduction to the design, optimisation and automation of a data pipeline.

content of teaching

The introductory course on data engineering covers fundamental concepts, architectures and tools for capturing, processing and delivering large and heterogeneous datasets, with a focus on applications in machine learning. The aim is to build scalable data infrastructures and automated data pipelines for ETL and ELT processes to efficiently transform raw data into analysable formats.

Building on principles of data modelling and storage, the course covers methods for data ingestion (batch and streaming), cleansing, transformation and storage. Students learn to use tools (e.g. Pandas) and gain insights into modern storage solutions such as data lakes and data warehouses, as well as methods for ensuring data quality, consistency and traceability.

Further topics include data augmentation, feature stores, data versioning and the integration of AutoML components into ML workflows. An overview of cloud-based data processing (e.g. AWS, GCP, Azure) and the use of relevant services for orchestration and scaling round off the course.
In the accompanying tutorials, the content covered is put into practice, including the setup and monitoring of a complete end-to-end data pipeline – from data ingestion to model evaluation.

Learning outcomes

Students …
... understand the fundamentals of data engineering and its significance for machine learning.
... learn how to build and manage complete data pipelines to support ML projects.
... acquire knowledge of how to use current tools for automating data workflows.

... are able to optimise data processing workflows and utilise cloud-based data infrastructures.

... can integrate data transformation, augmentation and versioning into ML pipelines.

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Data Engineering	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Data Engineering"	P	30 (2 contact hours)	30

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Oral examination on (1) and (2). If there are a large number of participants, the examiner may set a 90–120-minute written examination instead of an oral examination; this change to the examination format will be announced in the first module appropriate form.	20–30 min.	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Completing exercises; this includes presenting and discussing the results	Weekly assignment sheets (1–2 pages in length), presentation and discussion: 5–10 minutes per candidate	2

5	Allocation of workload	
Participation (attendance or contact time)	Course No. 1	1 credit
	Course No. 2	1 credit
SL No. 1		1 LP
PL No. 1		2 LP
Total LPs		5 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	Prerequisites
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Every summer semester	
Person responsible for module	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 14 – Earth Sciences

8	Mobility/Recognition
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a specialisation in Computer Science), Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Data Engineering
English translation of the module components from field 3	Course No. 1: Data Engineering
	Course No. 2: Recitation Sessions on "Data Engineering"

9	Miscellaneous
	Admission to the examination is conditional upon the successful completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Data Science Project
Module number	DSM-DS-103

1	**Prerequisites**
Subject related semester for students	3
Credit points (CP)	15
Total workload (hours)	450
Duration of the module	1 semester
Modules status (P/WP)	P

2	**Profile**

Aims of the module/integration into the curriculum

The aim of the project module is to introduce students to independent academic work through the completion of a research- or practice-oriented project and to prepare them for their Master's thesis. Students tackle a complex problem from an applied science using data science methods, particularly machine learning. The project can be carried out individually or in interdisciplinary groups, as well as in collaboration with external partners, e.g. from industry. In doing so, students strengthen their skills in the independent planning, implementation and reflection of data-driven analysis processes, as well as in the written and oral presentation of scientific results.

content of teaching

The content of teaching depends on the chosen format: an interdisciplinary group project (Component 1), an independent project in a research context (Component 2), or a work placement (Component 3).

Regarding Component 1: In this component, students work in coordinated groups on a complex, practice-oriented project in the field of data science, focusing on data-driven methods, particularly machine learning. The topics are usually proposed by teaching staff from the relevant departments of the master course and are based on real-world problems from academia or industry. In an introductory seminar phase, students – supported by current literature and in close consultation with their supervisors – acquire the technical fundamentals of the project topic. The results presented in seminar talks serve to refine the project proposal and select suitable data sources and analytical methods. Building on this, the groups develop a data-driven solution strategy, which they implement in a complete project – from data preparation through exploratory analysis and modelling to evaluation and documentation. The implementation follows established best practices in data science, for example regarding reproducibility, code quality and ethical considerations. The results are presented in a final report and a presentation. Throughout the project, students receive subject-specific and technical supervision and are supported in reflecting on and coordinating their work through regular meetings

Regarding Component 2: In this component, students undertake an independent, clearly defined research project with strong links to an academic research group at a university or within an industrial setting, with integration into a work placement (potentially also in the

abroad) with a clear research component. In principle, both can also take place at a different location or abroad. The aim is to actively contribute to a current research question over an extended period, applying data science methods – particularly from the field of machine learning – to a specific problem in an applied science such as Chemistry. The projects foster an understanding of the interdisciplinary connections between the research topic and key content of the MSc data science programme, and strengthen the ability to conduct independent scientific work in a research environment.

Regarding Component 3: In this component, students undertake a work placement at a research-oriented or industrial institution that has a clear connection to data science methods. The placement can be carried out in Germany or abroad and is intended to enable students to apply data science concepts in a real-world working context. The focus is on the practical implementation of data-driven methods, particularly from the field of machine learning, to solve application-oriented problems. In doing so, students are intended to gain insight into operational processes, project management, interdisciplinary collaboration, as well as ethical and societal issues surrounding the practical application of data science. The results are documented in a final report, which reflects on the connection between theoretical methods and practical implementation.

Learning outcomes

Students ...
... learn to clarify and define a complex, practical problem in the field of data science with unclear parameters;
... learn to plan and implement a complete data-driven project using appropriate machine learning methods through a division of labour;
... learn to identify, prepare and critically analyse suitable data sources;
... learn to develop, evaluate and select data-based solutions on a reasoned basis;
... learn to search for and utilise scientific literature in a targeted manner for their own project;
... learn to present project results and analysis processes in a structured and audience-appropriate manner, both in writing in a final report and orally in a presentation.

In Component 1, through group work, students acquire skills in cooperative project organisation, interdisciplinary collaboration, and the coordination and integration of different individual contributions into a joint data science solution.

In the individual project (Components 2 and 3), students deepen their ability to conduct independent academic work, in particular through long-term collaboration within a research group, the independent management of a defined project component, and the close integration of data science methods with discipline-specific research questions.

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Practical	Project	Data science project	WP	90 (6 contact hours)	360
2	Practical	Work placement	Work placement	WP	300 hours / 20 contact hours	150 hours
3	Work placement	Work placement	Work placement	WP	–	450 hours

Options within the modules:

Students may choose one of the two components.
Within Component 1 (Interdisciplinary Group Project), a selection of interdisciplinary projects on various topics is organised. Students choose one of these projects and, in consultation with the respective organiser, can help shape its focus.

In Component 2, the research project is carried out: this takes place either in close consultation with a lecturer from one of the participating departments. Alternatively, it may be conducted as part of a collaboration with an external research institution, including abroad and, where appropriate, as a block course. The choice of topic is made in consultation with the supervising lecturer. Final approval of the project is granted by the module coordinator or, in the case of collaboration with industry (potentially abroad and as a block course), by the relevant industry partner. To this end, students must have successfully applied for a suitable placement. The suitability of the placement must be clarified with a lecturer from the relevant departments before the placement begins.

Component 3: An industrial placement is carried out in collaboration with a research-oriented or industrial organisation. Students apply independently for a suitable placement. The suitability of the placement must be clarified prior to commencement in consultation with a lecturer from the relevant departments and the module coordinator. Internships may also be undertaken abroad and organised as a block work placement, provided they meet the content requirements for a data science project

4	**Examination structure**				
Assessment					
No.	MAP / MTP	Type	Duration/scope	Organisational links (if applicable) to Course No.	Weight and module mark
1	MAP	Students must complete two minor assessment tasks (e.g. short presentations, written assignments or tests) or one major assessment task (e.g. a seminar paper or written examination).	Two minor assessments (short presentations of 10–20 minutes each, short written assignments of 5–7 pages, each accounting for half the mark) or one major assessment (a seminar paper of 10–20 pages or a 90-minute written examination).	1	100%
2	MAP	Final report	Subject-specific, 20–40 pages	2 or 3	100%
Weighting of the module mark in the final mark			13.05%		

Coursework			
No.	Type	Duration/scope	Organisational links (if applicable) to course No.
1			

5	Allocation of workload	
Attendance (contact hours)	a) Course No. 1	3 credits
	b) Course No. 2	10 credits
	c) Course No. 3	0 credits
Coursework (and self-study)	a) Course No. 1	3 credits
Examination performance (and self-study)	a) PL No. 1	9 credits
	b) PL No. 2	5 credits
	c) PL No. 2	15 credits
Total LP		15 credits

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	Prerequisites
Module-specific entry requirements	No formal entry requirements. However, see the "Other"
Attendance regulations	As the course is project-based, regular attendance at project meetings is expected. Students who miss more than 20% of the sessions are not entitled to sit the examination.

7	Frequency of the module	
Frequency	Usually every semester	
Person responsible for module/Department	The current module coordinators can be found at https://uni.ms/datascience-mv .	All participating departments.

8	Mobility/Recognition
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a focus on Computer Science); Mathematics (M.Sc.), Mathematics (BA), Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Data Science Project

English translation of the module components from field 3	Course No. 1: Data Science Project
	Course No. 2: Internship
	Course No. 3: Industrial Internship

9	**Other**
	A sound knowledge of the introductory courses in data science and good programming skills are recommended. Depending on the thematic focus of the project, subject-specific prior knowledge in the relevant field of the offering discipline (e.g. Chemistry, Physics) may also be advisable. Any subject-specific prior knowledge required will be announced when the projects are advertised.

degree programme	Data Science (M.Sc.)
Modules	Master's degree module
Module number	DSM-DS-100

1	**Basic information**
Students' subject related semester	4
Credit points (CP)	30
Total workload (hours)	900
Duration of the module	1 semester
Modules status (P/WP)	P

2	**Profile**

Aims of the module/integration into the curriculum

The module comprises the independent completion of the Master's thesis and the accompanying Master's seminar. Students address an academic research question based on their own research activities, applying data science methods in the process. The aim is to deepen the skills acquired during the course of study in a written thesis and to communicate them academically.

content of teaching

The Master's thesis is carried out in consultation with a supervisor from the group of persons authorised in accordance with the examination regulations. The focus of the thesis is determined jointly with this supervisor; as a rule, this requires that the student has previously attended relevant courses taught by the supervisor. The Master's thesis is carried out within a research group in the department or – by arrangement – in cooperation with external institutions, e.g. from industry. In parallel, students take part in the Master's seminar, where they present their work in lectures. Participation in the department's specialist and interdisciplinary academic lecture programme of the department is expected.

Learning outcomes

Students …
… are able to independently address a research problem in the field of data science and in relation to an application domain, within a specified timeframe and using scientific methods.
… apply suitable methods for the analysis, modelling and evaluation of data-based problems independently and with sound reasoning.
… document their work in a comprehensible, appropriate and clear manner in a written academic paper.
… present their research question, methodological approach and results in a manner appropriate to the audience and are able to defend these competently in academic discourse.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-

						study (h)
1			Master's thesis	P		810 h
2	Seminar	Seminar	Master's seminar	P	30 hours	60 hours
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Master's thesis	60–100 pages	1	100%
Weighting of the module mark in the final mark			26.10%		
Coursework					
No.	Type			Duration/scope	Organisational link to course No. (if applicable)
1	Presentation and discussion of the Master's thesis			Presentation: 20–30 minutes, discussion: 15–30 minutes	2

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	0 credits
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	2 credits
Examination performance (and self-study)	Exam No. 1	27 credits
Total credits		30 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	**Prerequisites**

Module-specific entry requirements	The entry requirements are set out in Section 13 of the Examination Regulations for the master course in data science. Before registering for the Master's thesis, at least 60 credit points must have been earned from must have been acquired through completed modules.
Attendance regulations	There is no compulsory attendance.

7	**Modules schedule**	
Frequency	Every semester	
Person responsible for module/Department	Thesis supervisor	All participating departments

8	**Mobility/recognition**
Applicability to other degree programmes	None
Module language(s)	English
Module title in English	Master's Thesis and Seminar
English translation of the module components from field 3	Course No. 1: Master's Thesis
	Course No. 2: Master's Seminar

9	**Miscellaneous**
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degree programme	Data Science (M.Sc.)
Modules	Fundamentals of Natural Sciences
Module number	DSM-F-200

1	**Basic data**
Subject related semester	1st–2nd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	2 semesters
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

This module introduces fundamental concepts, principles and ways of thinking in the natural sciences, thereby laying an interdisciplinary foundation for further courses in various scientific disciplines. It is aimed in particular at students who, as part of their previous studies, have received little or no systematic introduction to scientific modelling, experimental methodology and fundamental physical concepts.
Particular emphasis is placed on understanding overarching structures – from scaling laws and model limitations to emergent phenomena in many-body systems – in order to facilitate engagement with more complex issues in physics, Earth Sciences, Chemistry, pharmacy and related subjects, and to

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content of teaching

The modules consist of two parts that are independent in terms of content but thematically linked, which can be completed in any order. Both parts have different focal points but, where necessary, draw on key concepts and methods from the other part.

Part I: Fundamentals of scientific thinking, modelling and measurement. The following topics are generally covered:

- Dimensions, units and orders of magnitude: scaling, dimensional analysis estimates.
- Experiment and measurement: collection and interpretation of measurement data, measurement uncertainties and critical analysis of data.
- Modelling and mathematical description: constructing simple models to describe physical, chemical and biological systems; the concept of model levels; limitations and scope of models.
- Complexity and dynamics: examples of emergent behaviour, collective variables and self-organisation; introduction to phenomena such as tipping points, chaos and amplification processes.
- Introduction to quantum phenomena: Basic concepts of quantum theory using simple models as examples.

In all areas, the methods are applied to gain a fundamental understanding

of various scientific fields – ranging from the structure of matter and

quantum information technology, energy and climate to issues in the life sciences.
Part II: Application of scientific principles to specific case studies
This part is devoted to the exemplary application of scientific concepts and ways of thinking to selected specialist questions. The focus is on specific case studies from the fields of physics, Chemistry, pharmacy, Earth Sciences and biology, which are analysed and reflected upon in a structured manner with the support of fundamental principles. The selection of topics is based both on subjects of fundamental importance to the respective fields and on current scientific developments. Key terms and methods from Part I are introduced or revisited as required, so that Part II can be undertaken independently. The aim is to teach students how fundamental scientific ways of thinking can be linked with in-depth domain-specific knowledge in order to address complex issues from research and

application.

Learning outcomes

Students …
… develop a fundamental understanding of dimensions, units and orders of magnitude,
… learn how insights into scientific relationships – from the structure of matter to the fundamental properties of living organisms – can be derived from this,
… understand how experimental data is collected and scientifically analysed,
… understand the connection between mathematical modelling and natural processes, as well as the limitations of different levels of modelling,
… are able to independently construct simple models and draw conclusions from them – for example, regarding phenomena such as tipping points, chaotic behaviour or self-reinforcement,
… acquire a fundamental understanding of key quantum phenomena,
… understand which novel phenomena arise when considering systems with many interacting components, and which methods are required to describe them,
… learn how to use this knowledge to independently familiarise themselves with more advanced questions in various scientific disciplines,
… understand how fundamental scientific principles can be applied to specific case studies in physics, Chemistry, pharmacy and biology,
… are able to analyse typical problems from various disciplines independently and select appropriate scientific approaches and methods,
… develop the ability to contextualise scientific concepts in an interdisciplinary manner and to reflect on them critically

— including with regard to their significance and limitations.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Fundamentals of scientific thinking, modelling and measurement	P	30 (2 contact hours)	30
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorial on "Fundamentals of scientific thinking, modelling and Measurement"	P	30 (2 contact hours)	60
3	Lecture	Lecture	Application of scientific principles to specific case studies	P	30 (2 contact hours)	30
4	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorial on "Applying scientific principles to specific case studies"	P	30 (2 contact hours)	60

Options within the modules: 2338
None

4	Examination format				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Written examination on (1) and (2)	90 mins	1	50%
2	MTP	Written examination on (3) and (4)	90 mins	3	50%
Weighting of the module mark in the overall mark			8.70%		

Coursework			
No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving practice problems, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2
2	Solving practice problems, presentation and discussion of the results	Weekly exercise sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	4

5	Allocation of workload	
Participation (attendance or contact time)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1 LP
	Course No. 4	1 credit
Coursework (and self-study)	SL No. 1	1 credit
	SL No. 2	1 credit
Examination requirements (and self-study)	PL No. 1	2 credits
	PL No. 2	2 credits
Total credits		10 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	Prerequisites
Module-specific entry requirements	No formal prerequisites; however, a basic knowledge of calculus and linear algebra is strongly .
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency/Schedule	The modules can be started at the beginning of any semester, as the two parts can be taken independently of one another	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Centre for Data Science and Complexity

8	Mobility/Recognition
Applicability to other degree programmes	Geoinformatics and Spatial Data Science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Fundamentals of Natural Science
English translation of the module components from field 3	Course No. 1: Fundamentals of scientific thinking, modelling, and measurement
	Course No. 2: Recitation Sessions on Fundamentals of scientific thinking, modelling, and measurement
	Course No. 3: Application of scientific principles to specific case studies
	Course No. 4: Recitation Sessions on the Application of Scientific Principles to Specific Case Studies

9	Miscellaneous
	Admission to the examination is conditional upon the successful completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Advanced Mathematics
Module number	DSM-F-201

1	**Basic data**
Subject related semester	1st–2nd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	2 semesters
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

In this module, students are introduced to the fundamental methods of both stochastics and numerical analysis.

content of teaching

Part I: Fundamentals of stochastics and probability theory
The lecture is an introduction to stochastics. Key topics include: elementary discrete probability theory (law of total probability, Bayes' theorem, etc.), random variables and their parameters (expected value, variance); probability distributions and their properties (Bernoulli, binomial, hypergeometric, Poisson, geometric and normal distributions), modelling using such distributions, the law of large numbers, the central limit theorem, estimation methods and elementary hypothesis testing.
Part II: General Concepts of Modelling and Simulation
This lecture provides an introduction to the fundamentals of modelling and simulation, with a focus on model-based data analysis. As simulation methods are applicable to a wide variety of problem classes, the lecture is structured around these methods. The focus is on continuous models and their numerical treatment, for example using ordinary differential equations and similar problems. The numerical topics include interpolation, integration, stability and well-posedness, as well as selected discretisation methods (e.g. single-step methods, time-step control) and linear

and non-linear solvers (e.g. Newton's method, Krylov method).

Learning outcomes

1. Fundamentals of stochastics and probability theory
Students have a command of key probability distributions and are familiar with their properties; they can apply these distributions for modelling, are familiar with key parameters of a random variable (expected value, variance) and know how to work with them; they are familiar with central theorems of stochastics (Bayes' theorem, total probability theorem, law of large numbers, central limit theorem). Mastery of elementary approaches in statistics.

2. General concepts in modelling and simulation

Students will master basic modelling techniques, learn about a range of discrete and continuous models and how to simulate them, and gain proficiency in the fundamental error and efficiency analysis of numerical methods.

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Lecture: Fundamentals of Stochastics and Probability Theory	P	30 (2 contact hours)	30
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on the fundamentals of stochastics and probability theory	P	30 (2 contact hours)	60
3	Lecture	Lecture	Lecture General Concepts of Modelling and Simulation	P	30 (2 contact hours)	30
4	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on General Concepts of Modelling and Simulation	P	30 (2 contact hours)	60

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Written examination on (1) and (2)	90 mins	1	50%
2	MTP	Written examination on (3) and (4)	90 mins	3	50%
Weighting of the module mark in the overall mark			8.70%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Completion of theoretical and practical exercises, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2
2	Completion of theoretical and practical exercises, presentation and discussion of results	Weekly exercise sheets	4

		(1–2 pages in length), presentation and discussion 5–10 minutes per candidate	

5	Allocation of workload	
Participation (attendance or contact time)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1 LP
	Course No. 4	1 credit
Coursework (and self-study)	SL No. 1	1 credit
	SL No. 2	1 credit
Examination requirements (and self-study)	PL No. 1	2 credits
	PL No. 2	2 credits
Total credits		10 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes have been acquired.

6	Prerequisites
Module-specific entry requirements	A sound knowledge of analysis and linear algebra is strongly recommended. Programming skills are recommended and will be developed further during the course.
Attendance policy	Attendance at the courses is strongly recommended.

7	Modules schedule	
Frequency	The modules can be started at any point in the semester, as the two parts can be taken independently of one another	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	Mobility/Recognition

Applicability to other degree programmes	No
Module language(s)	English
Module title in English	Mathematical Foundations
English translation of the module components from field 3	Course No. 1: Lecture Foundations of stochastics and probability theory
	Course No. 2: Recitation sessions on Foundations of stochastics and probability theory
	Course No. 3: Lecture: General concepts of modelling and simulations
	Course No. 4: Recitation sessions on General concepts of modelling and simulations

9	**Miscellaneous**
	Admission to the examination is subject to the successful completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Fundamentals of Software Development, Algorithms, and Data Structures
Module number	DSM-F-202

1	**Entry requirements**
Subject related semester	1st–2nd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	2 semesters
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

This module provides the fundamental concepts, methodologies and content of computer science that are prerequisites for attending more advanced computer science lectures. This module is intended only for students who did not take introductory lectures in the areas of programming, algorithms and data structures during their previous Bachelor's degree.

content of teaching

Part I: Fundamentals and concepts of (object-oriented) software development: object orientation, test-driven software development, text and file processing, abstract data types. The following topics are generally covered:

- Object-oriented programming: objects and classes, encapsulation, inheritance and type hierarchies, interfaces, polymorphism.
- Test-driven software development: unit tests, debugging, commenting.
- Text and file processing: operations on strings and files.
- Abstract data types: ADT Stack and ADT Queue with implementations.

Part II: Overview of algorithms and data structures, basic concepts of computability and complexity, searching and sorting, list structures, trees and graphs. The following topics are generally covered

Data structures: Lists, multidimensional arrays, address calculation methods, tree structures, graphs.

Algorithms: Basic search and sorting methods, graph traversals, shortest path calculation.

Paradigms: Greedy, divide-and-conquer.

Analysis of algorithms: Landau notation

Learning outcomes

Students …
… understand fundamental modelling and modularisation concepts in (object-oriented) software development and are able to apply them effectively to model real-world situations,

... learn how to apply these concepts in practice using an object-oriented programming language,
... acquire practical skills in test-driven software development,
... understand how to fundamentally conceive and design solutions to IT problems.
... learn the targeted selection, development and implementation of algorithms and data structures, and
... are able to estimate the computational costs of calculations and can classify them.

3	**Structure**

Components of the module

No.	Syllabus Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Software Development Fundamentals	P	30 (2 contact hours)	30
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorial on "Software Development Fundamentals"	P	30 (2 contact hours)	60
3	Lecture	Lecture	Algorithms and Data Structures for Data Science	P	30 (2 contact hours)	30
4	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorial on "Algorithms and Data Structures for data science"	P	30 (2 contact hours)	60

Options within the modules:

None

4	**Examination format**

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Written examination on (1) and (2)	90 mins	1	50%
2	MTP	Written examination on (3) and (4)	90 mins	3	50%
Weighting of the module mark in the overall mark			8.70%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Successful completion of tutorial tasks. This also means that students may be required to present their results during the tutorials. This will be announced in a suitable manner in good time at the start of the course. The course content relates to courses 1 and 2.	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

2	Successful completion of tutorials. This also means that candidates may be required to present their results during the tutorials. This will be announced in a suitable manner in good time at the start of the course. The coursework relates in content to courses 3 and 4.	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5– 10 minutes per candidate	4

5	**Allocation of workload**	
Participation (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1 LP
	Course No. 4	1 credit
Coursework (and self-study)	SL No. 1	1 credit
	SL No. 2	1 credit
Examination requirements (and self-study)	PL No. 1	2 credits
	PL No. 2	2 credits
Total credits		10 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the
  learning outcomes have been achieved.

6	**Prerequisites**
Module-specific entry requirements	No formal prerequisites; however, it is recommended that students are familiar with the basics of imperative programming.
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency/Schedule	The modules can be started at the beginning of any semester, as the two parts can be taken independently of one another	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	**Mobility/Recognition**

Applicability to other degree programmes	Geoinformatics and Data Science (M.Sc.); Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Fundamentals of Software Development, Algorithms, and Data Structures
English translation of the module components from field 3	Course No. 1: Lecture on Software Development Fundamentals
	Course No. 2: Recitation Sessions on Software Development Fundamentals
	Course No. 3: Lecture on Algorithms and Data Structures for data science
	Course No. 4: Recitation Sessions on Algorithms and Data Structures for data science

9	**Miscellaneous**
	Admission to the examination is conditional upon the completion of coursework.

Additional skills

degree programme	Data Science (M.Sc.)
Modules	Additional skills
Module number	DSM-DS-110

1	**Entry requirements**
Students' subject related semester	2
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	P

2	**Profile**
Aims of the module/integration into the curriculum	
Sharpening the individual profile through key and cross-disciplinary competences.	
content of teaching	
The content of teaching depends on the selected components. Regarding component no. 1: Students supervise a tutorial group for a course offered by one of the participating departments or as part of the master course in data science. Regarding component no. 2: During a work placement at a company where data science methods are applied or whose activities relate to topics in the field of data science, students gain an insight into everyday working life. Under the guidance of company staff, they undertake typical tasks in a professional environment. The work placement must last four weeks with full-time attendance at the company and must be approved by a lecturer from the participating departments before it begins. Upon completion of the placement, a placement report must be submitted to the approving lecturer. Regarding component no. 3: Students attend modules and courses from a subject other than their main area of specialisation. This offers them the opportunity, in particular, to develop their interdisciplinary skills in a further subject.	

Learning outcomes
The learning outcomes depend on the chosen component. Component 1: Tutorial supervision and marking Students learn to communicate content from the field of data science or one of the applied sciences in a clear and accessible manner, and to evaluate it critically. They consolidate their specialist knowledge and develop their analytical and communication skills. Component 2: Work placement Students gain an insight into the professional applications of data science and learn to apply data science methods in a practical context. Component 3: Interdisciplinary supplementary courses Students acquire complementary skills outside their main area of specialisation, e.g. in ethics, law or communication. The specific learning objectives depend on the chosen subject area.

3	**Structure**					
Components of the module						
No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1			Tutorial supervision	WP	60 h	90 h
2	Work placement	Work placement	Work placement (four weeks with full-time attendance at the workplace)	WP		150 hours
3		Lecture /sem seminar	Course from a subject other than the student's chosen specialisation	WP		

Options within the modules:
Students may only complete Component 1 if they have successfully applied for a position as a student assistant for the relevant course. There is no legal entitlement to be appointed as a student assistant and thus to participate in these components. For component no. 2, students must have successfully applied for a suitable internship placement. The suitability of the internship placement must be clarified with a lecturer from the relevant departments before the placement begins. Under No. 3, no courses may be credited that form part of the compulsory courses of the data science degree programme or the compulsory elective courses of the chosen specialisation within it. Courses to be credited under No. 3 must have a clearly defined coursework or examination requirement that must be completed and passed in order to achieve the learning outcomes, and the module descriptions must clearly indicate the allocation of credit points. For credit to be awarded, all coursework and examination requirements associated with the course must be successfully completed. Students must obtain written consent from the lecturer regarding the number of credit points allocated to this course and permission to undertake this course as part of the 'Additional Skills' module of the master course in data science.

4	Examination format

Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	The examination and coursework requirements depend on the chosen modules. Depending on the chosen components, a varying number of examinations may be required. Components 1 and 2 are completed without an examination, but only with the associated coursework (see below).			
Weighting of the module mark towards the overall mark			0%		

Coursework			
No.	Type	Duration/scope	If applicable, link to course No.
1	Marking of exercise tasks as part of a teaching assistant role		1
2	Preparation of a placement report, which must be signed off by a lecturer	8–16 pages	2
3	As specified by the department offering the course		3

5	Allocation of the workload	
Attendance (contact hours)	Course No. 1	2 credits
	Course No. 2	None
	Course No. 3	Depending on the course chosen
Coursework (and self-study)	SL No. 1	3 ECTS
	Course No. 2	5 credits
	Course No. 3	Depending on the modules chosen
Examination requirements (and self-study)	PL No. 1	None
	PL No. 2	None
	PL No. 3	Depending on the selected LV
Total LP		5 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes have been acquired.

6	Prerequisites
Module-specific entry requirements	No entry requirements. However, please refer to the notes and regulations under 'Elective options'.
Attendance regulations	There is no compulsory attendance for components 1 and 2. For Component 3, see section 9 "Miscellaneous".

7	Modules schedule	
Frequency	Every semester	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	All participating departments

8	Mobility/recognition
Applicability to other degree programmes	None
Module language(s)	English
Module title in English	General Studies
English translation of the module components from field 3	Course No. 1: Student Assistantship I
	Course No. 2: Internship in Industry
	Course No. 3: << Depending on the chosen modules >>
	Course No. 4: << Depending on the chosen course >>

9	Miscellaneous
	Admission to the examination is conditional upon the successful completion of coursework. If courses from other degree programmes are offered as part of this module, the relevant examination regulations in their current version shall apply to registration and withdrawal procedures, compulsory attendance, and participation in and passing of coursework and examinations.

Specialisation: Mathematical and Computational Data Science

degree programme	Data Science (M.Sc.)
Modules	Advanced Machine Learning
Module number	DSM-MI-300

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. To this end, this module may be taken as part of the compulsory elective area within the core data science module. Students must complete modules totalling 5 ECTS credits from this area (modules DSM-MI-30x).

content of teaching

The Advanced Machine Learning module covers advanced approaches to machine learning. Depending on the specific structure of the course, different areas of focus may be emphasised – such as computational methods, mathematical and statistical foundations, or theoretical concepts of learning. Possible topics include, for example, in-depth modelling approaches, data-driven approaches, probabilistic methods, structural or Bayesian learning, representation learning, generalisation theory, causal inference, specialisations in research-intensive deep learning focus areas (such as NLP or computer vision), or learning algorithms in specific application areas.

The modules aim to integrate different disciplinary perspectives in a complementary manner – e.g. from mathematics, computer science or related disciplines – to facilitate an in-depth and multifaceted understanding of modern learning methods. Theoretical, computational and

application-oriented approaches are deliberately interrelated.

Learning outcomes

Students ...
... have gained an in-depth overview of advanced approaches to machine learning and their methodological foundations.
... understand key concepts, models and learning methods and can contextualise these from

mathematical, theoretical and algorithmic perspectives.

… are able to critically analyse advanced machine learning methods and apply them to complex problems in various fields of application. … are equipped to integrate different perspectives (e.g. computational, mathematical, theoretical) and to make their own contributions to interdisciplinary discussions in the field of machine learning.

3	**Structure**					
Components of the module						
No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Lecture: Advanced Machine Learning	P	60 (2 contact hours per week)	120
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials for the Advanced Machine Learning lecture	P	30 (2 contact hours)	90
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 20- to 30-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules .	120–180 min.	1	100%
Weighting of the module mark in the overall mark			8.70%		
Coursework					
No.	Type		Duration/scope		Organisational details (if applicable) Link to course No.
1	Completing exercises, presenting and discussing the results.		Weekly exercise sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate		2

5	Allocation of workload	
Attendance (contact hours)	Course No. 1	2 credits
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	3 credits
Examination performance (and self-study)	Exam No. 1	4 credits
Total credits		10 ECTS

The module's workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	Prerequisites
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Irregular	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science, Department 14 - Earth Sciences

8	Mobility/Recognition
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Mathematics (M.Sc.), Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Advanced Machine Learning
English translation of the module components from field 3	Course No. 1: Lecture on Advanced Machine Learning
	Course No. 2: Recitation Sessions on Advanced Machine Learning

9	Miscellaneous
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Advanced Machine Learning Seminar
Module number	DSM-MI-305

1	**Entry requirements**
Students' subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. To this end, this module may be taken as part of the compulsory elective area within the core Data Science module. Students must complete modules totalling 5 ECTS credits from this area (modules DSM-MI-30x).
The modules specifically promote students' abilities to engage with academic literature, to present complex machine learning content appropriately in both written and oral form, and to discuss complex issues. They thus serve as important preparation

for the Master's thesis and can also prepare students for it in terms of content.

content of teaching

The course organiser selects an area from the field of advanced machine learning for the seminar and compiles a series of topics from this area to be covered in the seminar. For each topic, they select one or more original articles. Each student chooses one of these topics and, using the original literature provided, familiarises themselves with the given topic largely independently. In doing so, they critically engage with the content of the original literature and research and study further literature that is necessary for understanding or that rounds off their understanding. In a written paper, the participant presents an overview of the topic in their own words and presents and discusses the topic in a lecture to the other students and the seminar supervisors. They attend the lectures given by the other students and actively participate in the discussions on the other topics.

When familiarising themselves with the topic, writing the paper and preparing the presentation, participants are supported by a supervisor from the working group of the respective course organiser. At the discretion of the respective course organiser, a seminar may also include additional components introducing academic working methods. Depending on the topic, participants may also be required to produce prototypes of selected software components.

Learning outcomes
Students will... … learn to familiarise themselves largely independently with a challenging academic topic in the field of machine learning, … learn to critically engage with the content of academic publications and to research and obtain the necessary literature. … learn to present complex scientific computer science content appropriately in written and oral and to discuss such content in a professional manner.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Seminar	Seminar	Advanced Machine Learning Seminar	P	30 (2 contact hours per week)	120

Options within the modules:

None

4	**Examination format**

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting of module mark
1	MAP	Seminar presentation and seminar paper	30–45 min. presentation, 10–20-page paper	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	None		

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	1 credit
Coursework (and self-study)		
Examination requirements (and self-study)	Course No. 1	4 credits
Total credits		5 credits

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or academic achievements, it is nevertheless allocated to the credits.

- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes assigned to the learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every semester	
Person responsible for module/Department	The current module coordinators can be found at https://uni.ms/datascience-mv .	Department 10 – Mathematics and Computer Science, Department 14 - Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Mathematics (M.Sc.), Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Advanced Machine Learning Seminar
English translation of the module components from field 3	Course No. 1: Advanced Machine Learning Seminar

9	**Other**

degree programme	Data Science (M.Sc.)
Modules	Autonomous Systems and Mobile Robots
Module number	DSM-MI-320

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

This module provides theoretical and practical foundations in methods for controlling autonomous systems. A focus is on methods for developing robust controllers for the adaptive behaviour of mobile robots. This includes perception and motion control techniques. This is accompanied by practical implementation in (simulated) robots. This direct application provides motivation for the individual methods and also directly introduces students to the integration of mechanisms and the development of a holistic view of dynamic systems

and their embedding in more complex architectures for autonomous systems.

Learning outcomes

Students ...
... gain an overview of the methods and architectures of autonomous systems,
... are familiar with various sensor technologies and their pre-processing,
... understand the mathematical principles underlying the coordination of movements,

... are able to independently implement basic control mechanisms.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Autonomous Systems and Mobile Robots	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Autonomous Systems and Mobile Robots"	P	30 (2 contact hours)	30

Options within the modules:

None

4	Examination format				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on 1) and 2) If there are few participants, the examiner may conduct a 20-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	90–120 min	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework			
No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Completing exercises, presentation and discussion of results	Two weekly exercise sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	Allocation of workload	
Participation (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	Exam No. 1	2 credits
Total credits		5 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	Prerequisites
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Usually every 2 years	
Person responsible for module/Department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	Mobility/Recognition
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Introduction to Autonomous Systems
English translation of the module components from field 3	Course No. 1: Introduction to Autonomous Systems and Mobile Robots
	Course No. 2: Recitation Sessions on "Introduction to Autonomous Systems and Mobile Robots"

9	Miscellaneous
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Automated Planning and Acting
Module number	DSM-MI-321

1	**Basic information**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

The module deals with models and methods in the research field of automated planning and subsequent action. The tutorial (in connection with lecture/seminar) offers the opportunity to explore selected topics in greater depth. Various formalisations, problem definitions and methods for solving these problems are covered, and their practical application is discussed using examples. Possible topics range from deterministic planning through temporal planning to probabilistic planning and decision-making.

Learning outcomes

Students ...
... understand the fundamentals of planning and action as well as theoretical formalisation,
... can evaluate different formalisms and solution methods and select them appropriately for problems in application domains,
... can apply these to new problems and evaluate them appropriately,

... thereby learn to work independently and with methodological depth on the basis of real-world problems in the field of artificial intelligence.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Automated Planning and Acting	P	45 (3 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Automated Planning and Acting"	P	15 (1 contact hour)	30

Options within the modules:

None

4	Examination structure	2362

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Oral examination on (1) and (2). If there are a large number of participants, the examiner may set a 90- to 120-minute written examination instead of an oral examination; this change to the examination format will be announced in good time at the start of the modules in an appropriate manner.	20–40 min.	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving practice problems, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	Allocation of workload	
Attendance (attendance or contact time)	Course No. 1	1.5 credits
	Course No. 2	0.5 credits
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	2 credits
Total credits		5 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes have been acquired.

6	Prerequisites 2363
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Usually every 2 years	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	Mobility/Recognition
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science)
Module language(s)	English
Module title in English	Automated Planning and Acting
English translation of the module components from field 3	Course No. 1: Automated Planning and Acting
	Course No. 2: Recitation Sessions on "Automated Planning and Acting"

9	Miscellaneous
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Computer Vision
Module number	DSM-MI-301

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. To this end, this module may be taken as part of the compulsory elective area within the core data science area. From this area (modules DSM-MI-30x), modules totalling

to complete 5 credits.

content of teaching

The 'Computer Vision' lecture deals with algorithms for the analysis and semantic interpretation of (camera) images and image sequences. A key focus is the use of deep learning methods, which today play a central role in the field of computer vision. These include, amongst others, neural networks for object recognition, image segmentation and image classification. Furthermore, current topics from research, such as Vision Transformers and generative models, are addressed. Another key focus is on classical methods relating to topics such as camera calibration, edge detection, contour- and region-based image segmentation, detection of points of interest, texture analysis, motion analysis, analysis of 3D images and robust estimators. Furthermore, the integration of these classical methods with deep learning methods will be covered.

Learning outcomes

Students ...
... analyse typical problems in computer vision and select suitable algorithmic approaches to solve them.
... explain key methods such as edge detection, image segmentation, interest point detection, motion analysis and 3D reconstruction, and describe how they work.
... implement basic computer vision algorithms and apply them independently to image and video data.
... evaluate both classical and deep learning-based methods in terms of their suitability for specific applications.
... develop simple systems for semantic image analysis and validate their results

using appropriate metrics.

3	Structure

Components of the module

No.	Specification Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Computer Vision	P	45 (3 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Computer Vision"	P	15 (1 contact hour)	30

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 30-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	90–120 min	1	100%
Weighting of the module mark towards the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
	None		

5	Allocation of workload

Attendance (contact hours)	Course No. 1	1.5 credits
	Course No. 2	0.5 credits
Coursework (and self-study)		
Examination performance (and self-study)	PL No. 1	3 credits
Total credits		5 credits

The workload of the module is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been

  has been successfully completed, i.e. by passing all examination components and

Academic achievements	have been	that	that	the	the	modules	have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every year in the winter semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv .	Department 10 – Mathematics and Computer Science Department 14 – Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a specialisation in Computer Science), Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Computer Vision
English translation of the module components from Field 3	Course No. 1: Computer Vision
	Course No. 2: Recitation Sessions on "Computer Vision"

9	**Miscellaneous**
	Only one of the modules “Computer Vision with Practical” or “Computer Vision” may be taken.

degree programme	Data Science (M.Sc.)
Modules	Computer Vision (with placement)
Module number	DSM-MI-306

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. To this end, this module may be taken as part of the compulsory elective area within the core data science area. From this area (modules DSM-MI-30x), modules totalling

5 ECTS credits must be completed.

content of teaching

The 'Computer Vision' lecture deals with algorithms for the analysis and semantic interpretation of camera images and sequences. A key focus is the use of deep learning methods, which today play a central role in the field of computer vision. These include, amongst others, neural networks for object recognition, image segmentation and image classification. Furthermore, current topics from research, such as Vision Transformers and generative models, are addressed. Another key focus covers classical methods such as camera calibration, edge detection, contour- and region-based image segmentation, detection of points of interest, texture analysis, motion analysis (optical flows, tracking), image databases, analysis of 3D images and robust estimators. Worksheets aligned with the lecture material are provided and discussed in accompanying tutorials (in connection with lecture/seminar).

In the practical session, students are required to carry out a project in the field of computer vision.

Learning outcomes

Students ...
... analyse typical problems in computer vision and select suitable algorithmic approaches to solve them.
... explain key methods such as edge detection, image segmentation, interest point detection, motion analysis and 3D reconstruction, and describe how they work.
... implement basic algorithms for image analysis and validate their results using real-world datasets.
... evaluate both classical and deep learning-based methods in terms of their suitability for specific applications.
... independently develop an application-oriented project in the

field of computer vision, making targeted use of appropriate methods.

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Computer Vision	P	45 (3 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Computer Vision"	P	15 (1 contact hour)	30
3	Practical	Practical	Internship on "Computer Vision"	P	30 (2 contact hours per week)	120

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 30-minute oral examination instead of a written exam; this change to the examination format will be announced in good time at the start of the modules in an appropriate .	90–120 min.	1	67%
2	MTP	Oral presentation of the placement results; the assessment may be conducted as a group assessment. This will be announced by the lecturer at the start of the course.	5–10 min. per exam	3	33%
Weighting of the module mark in the overall mark			8.70%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Two smaller or one larger course project	Two smaller course modules: short presentation 10–20 minutes or a written paper of 5–7 pages (weighting each half)	3

		Major coursework assignment: Seminar paper of 10–20 pages or written examination (90 minutes)	

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	1.5 credits
	Course No. 2	0.5 credits
	Course No. 3	1 credit
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	Exam No. 1	3 credits
	PL No. 2	3 credits
Total credits		10 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules content**	
Frequency/Timing	Usually every year in the winter semester	
Person responsible for module/Faculty	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science Department 14 – Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a focus on Computer Science), Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English

Module title in English	Computer Vision with Practical Training
English translation of the module components from field 3	Course No. 1: Computer Vision
	Course No. 2: Recitation Sessions on "Computer Vision"
	Course No. 3: Practical Training on "Computer Vision"

9	**Miscellaneous**
	Students may only enrol in one of the modules “Computer Vision with Practical Training” or “Computer Vision”. If, in the module “Computer Vision with Practical Training”, only the written or oral examination is passed, the student may switch to the module “Computer Vision”. This examination result will then be recognised for the module “Computer Vision”. Admission to the examination is conditional upon the completion of the required coursework.

degree programme	Data Science (M.Sc.)
Modules	Data Protection Technologies
Module number	DSM-MI-322

1	**Basic information**
Students' subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

The course provides knowledge of problems and possible solutions relating to the electronic processing of data requiring protection. The primary focus is on the protection of personal data. However, many of the solutions discussed are also applicable to the protection of other sensitive data (e.g. trade secrets).

At the start of the course, data protection is placed within a broader socio-technical context, relevant legal provisions are explained, and data protection is

distinguished from IT security. The majority of the course covers various types of privacy-enhancing technologies. This includes cryptographic methods (e.g.

homomorphic encryption, multi-party computation), data transformation-based methods (e.g. anonymisation, differential privacy) and system-based methods (e.g.

access control, trusted execution environments). Finally, selected applications of privacy-enhancing technologies (e.g. in the field of machine learning) are covered.

Learning outcomes

Students ...
... are aware of threats to data protection and can formulate the associated security models.
... are familiar with possible technical measures for data protection and can apply these as required.
... are able to analyse the impact of privacy-enhancing technologies on both data protection and other quality characteristics, thereby enabling them to make informed decisions regarding the use of such technologies.
... have knowledge of the current state of research in the field of technical

data protection.

3	Structure

Components of the module

No.	LV Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Data Protection Technologies	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Data Protection Technologies"	P	30 (2 contact hours)	30

Options within the modules:

None

4	Examination structure

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2). If there are few participants, the examiner may conduct a 20–30-minute oral examination instead of a written examination; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	90 mins	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving exercises, presentation and discussion of results”	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	Allocation of workload

Participation (attendance or contact time)	Course No. 1	1 credit
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	2 credits
Total credits		5 ECTS

The module's workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually once a year or every two years	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Data Protection Technologies
English translation of the module components from field 3	Course No. 1: Data Protection Technologies
	Course No. 2: Recitation Sessions on "Data Protection Technologies"

9	**Miscellaneous**
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Deep Learning
Module number	DSM-MI-302

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective section of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. To this end, this module may be taken as part of the compulsory elective section of the entire data science degree programme. From this section (modules DSM-MI-30x)

, modules totalling 5 ECTS credits must be completed.

content of teaching

The module provides in-depth knowledge of modern deep learning methods, models and training procedures. Building on fundamental concepts of neural networks (see the module “Introduction to Machine Learning”), current architectures such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), Transformer models and Graph Neural Networks (GNNs) are covered. Particular emphasis is placed on the theoretical and practical aspects of training, optimisation and generalisation of deep neural networks.

Students will learn about advanced optimisation and training strategies, including transfer learning techniques, efficient model adaptation (e.g. low-rank adaptation) and modern regularisation methods. Topics such as hyperparameter tuning, data augmentation and methods for improving generalisation are covered, as are current insights into overfitting, memorisation and phenomena in very deep models (e.g. double descent).

In addition, generative models (e.g. autoencoders, GANs, diffusion models) are introduced and discussed in terms of their application and theoretical foundations. Furthermore, approaches to improving the efficiency of large models, such as model compression, pruning and quantisation, are presented.

The modules thus offer a comprehensive overview of current and future developments in the field of deep learning and enable students to understand, train and critically evaluate complex neural models.
In the tutorials, the approaches are applied in examples.

Learning outcomes

Students ...

... understand the structure, training principles and theoretical foundations of modern deep learning models.

… can select and apply different architectures (e.g. CNNs, RNNs, Transformers, GNNs) in a targeted manner.
… have mastered advanced training and optimisation strategies as well as methods for improving generalisation and efficiency.
… can apply generative models both conceptually and in practice, and critically evaluate their results.
… are able to develop, train and evaluate complex neural networks within the context of complete machine learning processes.

Overall, students thus acquire, through real-world problems, the skills to work independently and with methodological depth within a clearly defined specialist area of computer science.

3	**Structure**					
Components of the module						
No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Deep Learning	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Deep Learning"	P	30 (2 contact hours)	30
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Oral examination on (1) and (2). If there are a large number of participants, the examiner may set a 90–120-minute written examination instead of an oral examination; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	20–30 min.	1	100%
Weighting of the module mark towards the overall mark			4.35%		
Coursework					
No.	Type		Duration/scope	Organisational link to course No. (if applicable)	
1	Solving exercises, presentation and discussion of results”		Two weekly exercise sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2	

5	Allocation of workload	
Attendance (attendance or contact time)	Course No. 1	1 credit
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	Exam No. 1	2 credits
Total credits		5 ECTS

The workload of the module is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	Prerequisites	
Module-specific entry requirements	None	
Attendance policy	Attendance at courses is strongly recommended.	

7	Modules schedule	
Frequency	Usually every 2 years	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science Department 14 – Earth Sciences

8	Mobility/Recognition	
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a focus on Computer Science), Mathematics (M.Sc.), Mathematics (BA), Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)	
Module language(s)	English	
Module title in English	Deep Learning	
English translation of the module components from field 3	Course No. 1: Deep Learning	
	Course No. 2: Recitation Sessions on "Deep Learning"	

9	Miscellaneous
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Deep Reinforcement Learning
Module number	DSM-MI-303

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. To this end, this module may be taken as part of the compulsory elective area within the core data science area. From this area (modules DSM-MI-30x), modules totalling

5 ECTS credits must be completed.

content of teaching

The lecture provides an introduction to the theoretical background of reinforcement learning, neural networks and the application of deep reinforcement learning. Current approaches to deep reinforcement learning are presented, as they have been extensively researched in the field of decision-making in computer games. Furthermore, recent work on extending these approaches to real-world problems — such as locomotion and grasping in robotics — is covered.

The course begins by introducing fundamental theoretical concepts of reinforcement learning (including Markov decision processes, approximation of value functions and learning via policy gradients). It then covers the fundamental distinctions within reinforcement learning: first, the distinction between model-free and model-based methods, as well as related planning-based approaches. In addition, the distinction between online and offline learning approaches is covered. Current work in the field of deep reinforcement learning, in which deep neural networks are used for function approximation, is discussed, along with its theoretical foundations.

In the tutorials, the approaches are applied in examples.

Learning outcomes

Students ...
... understand the fundamentals and theory of reinforcement learning and sequential (Markov) decision processes,
… are able to classify and understand current approaches and associated learning methods from the field of deep

reinforcement learning,

... are able to assess the performance of the discussed methods and evaluate them appropriately, ... and can select and apply these methods in a targeted manner to problems in application domains.

3	**Structure**					
Components of the module						
No.	Specification Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Deep Reinforcement Learning	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Deep Reinforcement Learning"	P	30 (2 contact hours)	30
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Oral examination on (1) and (2). If there are a large number of participants, the examiner may set a 90–120-minute written examination instead of an oral examination; this change to the examination format will be announced in the first module appropriate form.	20–30 min.	1	100%
Weighting of the module mark in the overall mark			4.35%		
Coursework					
No.	Type		Duration/scope		Organisational links (if applicable) to course no.
1	Completing exercises, presentation and discussion of results		fortnightly exercise sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate		2

5	**Allocation of workload**	
Attendance (attendance or contact time)	Course No. 1	1 credit
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	1 credit

Examination performance (and self-study)	PL No. 1	2 credits
Total credits		5 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every 2 years in the winter semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Faculty 10 – Mathematics and Computer Science

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a specialisation in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Deep Reinforcement Learning
English translation of the module components from field 3	Course No. 1: Deep Reinforcement Learning
	Course No. 2: Recitation Sessions on "Deep Reinforcement Learning"

9	**Miscellaneous**
	Only one of the modules "Deep Reinforcement Learning with Practical" or "Deep Reinforcement Learning". Admission to the examination is subject to the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Deep Reinforcement Learning (with practical)
Module number	DSM-MI-307

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. To this end, this module may be taken as part of the compulsory elective area within the core Data Science module. Students must complete modules totalling 5 ECTS credits from this area (modules DSM-MI-30x).

content of teaching

The lecture provides an introduction to the theoretical background of reinforcement learning, neural networks and the application of deep reinforcement learning. Current approaches to deep reinforcement learning are presented, as they have been extensively researched in the field of decision-making in computer games. Furthermore, recent work on extending these approaches to real-world problems — such as locomotion and grasping in robotics — is covered.

The course begins by introducing fundamental theoretical concepts of reinforcement learning (including Markov decision processes, approximation of value functions and learning via policy gradients). It then covers the fundamental distinctions within reinforcement learning: first, the distinction between model-free and model-based methods, as well as related planning-based approaches. In addition, the distinction between online and offline learning approaches is covered. Current work in the field of deep reinforcement learning, in which deep neural networks are used for function approximation, is discussed, along with its theoretical foundations.

In the tutorials, the approaches are applied in examples.

As part of the practical course, a project in the field of deep reinforcement learning is to be carried out, demonstrating the application of deep neural networks in a reinforcement learning scenario. To this end, deep neural networks are introduced at the start of the practical course.

Learning outcomes
Students ... ... understand the fundamentals and theory of reinforcement learning and sequential (Markov) decision processes, ... are able to classify and understand current approaches and associated learning methods in the field of deep reinforcement learning, ... are able to assess the performance of the discussed methods and evaluate them appropriately, ... can select and apply these methods in a targeted manner to problems in application domains ... and learn about coordination and collaboration within a team and integration into a complete system during the practical component.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Deep Reinforcement Learning	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Deep Reinforcement Learning"	P	30 (2 contact hours)	30
3	Practical	Practical	Internship on "Deep Reinforcement Learning"	P	30 (2 contact hours per week)	120

Options within the modules:

None

4	**Examination structure**

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Oral examination on (1) and (2). If there are a large number of participants, the examiner may set a 90–120-minute written examination instead of an oral examination; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	20–30 min.	1	67%
2	MTP	Oral presentation of the practical work results; the examination may be conducted as a group examination. This will be announced by the lecturer at the start of the course.	Individual exam: 10–20 mins; group examination: 5–10 mins per candidate	3	33%
Weighting of the module mark in the overall mark			8.70%		

Coursework			
No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Completing practice exercises, presentation and discussion of results	Fortnightly exercise sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1 credit
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	2 credits
	PL No. 2	4 credits
Total credits		10 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every 2 years in the winter semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	Mobility/Recognition	
Applicability to other degree programmes		Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)		English
Module title in English		Deep Reinforcement Learning with Practical Training
English translation of the module components from field 3		Course No. 1: Deep Reinforcement Learning
		Course No. 2: Recitation Sessions on "Deep Reinforcement Learning"
		Course No. 3: Practical Training on "Deep Reinforcement Learning"

9	Miscellaneous
	Students may only enrol in one of the modules “Deep Reinforcement Learning with Practical Training” or “Deep Reinforcement Learning”. If, in the module “Deep Reinforcement Learning with Practical Training”, only the oral examination or the written examination is passed, the student may switch to the module “Deep Reinforcement Learning”. This examination result will then be recognised for the module “Deep Reinforcement Learning”. Admission to the examination is conditional upon the completion of the coursework.

degree programme	Data Science (M.Sc.)
Modules	Empirical Security Analysis and Engineering
Module number	DSM-MI-323

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

This lecture covers key concepts and principles developed by the security community through the application of empirical measurement and analysis methods. Using relevant research findings and real-world case studies, students will acquire the ability to assess and improve the security of real-world systems. A key focus is on methods for collecting operational data regarding a system's security. Further topics include: measuring the security of protocol and service deployments on the internet, the influence of human factors, the use of active scanning and passive monitoring in relation to network security, web security, mobile security, data protection, and the application of machine learning in security. Students learn how security components behave in practice and, building on this, how to arrive at technical solutions that are empirically

verifiable, functional and secure against realistic threats.

Learning outcomes

Students
... can describe key principles of internet-wide measurement and explain their significance for the security analysis of real-world systems.
... can critically evaluate the suitability and limitations of the principles and methods they have learnt, particularly with regard to their application in security-critical systems
... can independently select relevant methods for recording, measuring and analysing security-relevant technologies, apply them in practice and interpret the results obtained
... can systematically evaluate the measurement data obtained and use it to identify and assess security-relevant aspects of internet technologies
... can independently devise methodological approaches for the measurement and analysis of Internet technologies

3	Structure

Components of the module

No.	Syllabus Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Empirical Security Analysis and Engineering	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials for "Empirical Security Analysis and Engineering"	P	30 (2 contact hours)	30

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 25-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	90–120 min	1	100%
Weighting of the module mark towards the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to LV No. (if applicable)
1	Solving practice problems, presentation and discussion of results”	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	Allocation of workload	
Participation (attendance or contact time)	Course No. 1	1 credit
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	2 credits

Total credits		5 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every year in the winter semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Empirical Security Analysis and Engineering
English translation of the module components from field 3	Course No. 1: Empirical Security Analysis and Engineering
	Course No. 2: Recitation Sessions on "Empirical Security Analysis and Engineering"

9	**Miscellaneous**
	Only one of the modules "Empirical Security Analysis and Engineering (with practical)" and "Empirical Security Analysis and Engineering". Admission to the examination is subject to the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Empirical Security Analysis and Engineering (with practical)
Module number	DSM-MI 338

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

This lecture covers key lessons and principles that the security community has developed through the application of empirical measurement and analysis methods. Drawing on relevant research findings and real-world case studies, students will acquire the ability to assess and improve the security of real-world systems. A key focus is on methods for collecting operational data on system security. Further topics include: measuring the security of protocol and service deployments on the internet, the influence of human factors, the use of active scanning and passive monitoring in relation to network security, web security, mobile security, data protection, and the application of machine learning in security. Students learn how security components behave in practice and, building on this, how to arrive at technical solutions that are empirically verifiable, functional and secure against realistic threats.

In the research placement, students set themselves a challenging task with a high research component and solve it in a scientifically sound manner.

Learning outcomes

Students
... can describe key principles of internet-wide measurement and explain their significance for the security analysis of real-world systems.
… can critically evaluate the suitability and limitations of the principles and methods they have learnt, particularly with regard to their application in security-critical systems
... can independently select relevant methods for recording, measuring and analysing security-relevant technologies, apply them in practice and interpret the results obtained
... can systematically evaluate the measurement data obtained and use it to identify and assess security-relevant aspects of internet technologies
… can independently devise methodological approaches for the measurement and analysis of Internet technologies
... can independently design, develop and implement methodological approaches for measuring and analysing Internet technologies

… can conduct an independent empirical study on security-relevant technology in a scientifically sound manner and contextualise the results obtained in relation to current scientific literature

3	**Structure**					
Components of the module						
No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Empirical Security Analysis and Engineering	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Empirical Security Analysis and Engineering"	P	30 (2 contact hours per week)	30
3	Practical	Practical	Internship on "Empirical Security Analysis and Engineering"	P	30 (2 contact hours per week)	120
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 25-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	90–120 min	1	67%
2	MTP	Presentation of the internship results	20 mins	3	33%
Weighting of the module mark in the overall mark			8.70%		

Coursework			
No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving exercises, presentation and discussion of results”	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10	2

		minutes per candidate	

5	Allocation of workload		
Attendance (attendance or contact time)		Course No. 1	1 LP
		Course No. 2	1 LP
		Course No. 3	1 credit
Coursework (and self-study)		SL No. 1	1 credit
		SL No. 2	3 credits
Examination requirements (and self-study)		PL No. 1	2 credits
		PL No. 2	1 credit
Total credits			10 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	Prerequisites	
Module-specific entry requirements		None
Attendance policy		Attendance at courses is strongly recommended.

7	Modules schedule		
Frequency		Usually every year in the winter semester	
Person responsible for module/department		The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	Mobility/Recognition	
Applicability to other degree programmes		Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and Data Science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)		English
Module title in English		Empirical Security Analysis and Engineering with Practical Training
English translation of the module components from Field 3		Course No. 1: Empirical Security Analysis and Engineering
		Course No. 2: Recitation Sessions on "Empirical Security Analysis and Engineering"
		Course No. 3: Practical Training on "Empirical Security Analysis and Engineering"

9	**Miscellaneous**
	Only one of the modules “Empirical Security Analysis and Engineering (with practical training)” and "Empirical Security Analysis and Engineering". If, in the module “Empirical Security Analysis and Engineering (with practical training)”, only the written or oral examination is passed, the student may switch to the module “Empirical Security Analysis and Engineering”. This examination result will then be recognised for the module “Empirical Security Analysis and Engineering”. Admission to the examination is conditional upon the completion of the required coursework.

degree programme	Data Science (M.Sc.)
Modules	Supplementary Module in Computer Science (short) A
Module number	DSM-MI-324

1	**Basic data**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

A current or classic topic from the field of computer science (e.g. from the Department of Computer Science, the Department of Geoinformatics) with a connection to data science is presented in the lecture and explored in greater depth in the tutorials (in connection with the lecture/seminar)

This module serves to integrate courses into the curriculum that may be offered only once or

irregularly, e.g. because the lecturer is not permanently available. The specific content covered can be found in the course description for the respective course in the course

catalogue.

Learning outcomes

Students ...
... have gained an overview of the subject area covered in the lecture.
... understand the key concepts and can place new scientific findings within the current state of research.
... are familiar with key findings and can apply the techniques of the subject area to specific problems.
... are prepared to read and understand original academic literature in this subject area

understand.

3	**Structure**

Components of the module

No.	Curriculum Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Supplementary lecture in Computer Science	WP	30 (2 contact hours per week)	60

2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on Supplementary Lecture in Computer Science	WP	30 (2 contact hours per week)	30
3	Lecture	Lecture	Supplementary lecture in Computer Science	WP	45 (3 contact hours per week)	15
4	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials for the supplementary lecture in Computer Science	WP	15 (1 contact hour)	30
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 20- to 30-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	90–120 min.	1 or 3	100%
Weighting of the module mark towards the overall mark			4.35%		
Coursework					
No.	Type		Duration/scope		if applicable Organisational link to course No.
1	Completion of exercises, as well as the presentation and discussion of results, is required to an extent specified by the lecturer.		Weekly assignment sheets (1–2 pages in length), presentation and discussion: 5–10 minutes per student		2 or 4

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1.5 credits
	Course No. 4	0.5 credits
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	2 credits
Total credits		5 ECTS

The modules' workload is expressed in credit points. Please note: • The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results. • If time has been allocated for self-study (e.g. preparation for and follow-up on lectures, etc.) that is not directly related to examinations or coursework, this time is nevertheless counted towards the module's requirements. • Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the successful completion of all examinations and coursework that the learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Irregular	
Person responsible for module/department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science Department 14 – Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Selected Topics in Computer Science (small) A
English translation of the module components from field 3	Course No. 1: Lecture on Selected Topics in Computer Science
	Course No. 2: Recitation Sessions on "Selected Topics in CS"
	Course No. 3: Lecture on Selected Topics in Computer Science
	Course No. 4: Recitation Sessions on "Selected Topics in CS"

9	**Miscellaneous**
	If courses from other degree programmes are selected as part of this module, the relevant examination regulations in their current version shall apply to registration and withdrawal procedures, compulsory attendance, and participation in and passing of coursework and examinations. Admission to the examination is conditional upon the successful completion of the coursework.

degree programme	Data Science (M.Sc.)
Modules	Supplementary Module in Computer Science (short) B
Module number	DSM-MI-325

1	**Basic data**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**
Aims of the module/integration into the curriculum	
The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must totalling 30 ECTS credits must be completed.	
content of teaching	
A current or classic topic from the field of computer science (e.g. from the Institute of Computer Science, the Institute of Geoinformatics) with a connection to data science is presented in the lecture and explored in greater depth in the tutorials (in connection with the lecture/seminar). These modules serve to integrate courses into the curriculum that can only be offered once or on an irregular basis, e.g. because the lecturer is not permanently available. The specific content covered can be found in the announcement for the respective in the course catalogue.	
Learning outcomes	
Students ... ... have gained an overview of the subject area covered in the lecture. ... understand the key concepts and can situate new scientific findings within the current state of research. ... are familiar with key findings and can apply the techniques of the subject area to specific problems. ... are prepared to read and understand original academic literature in this subject area understand.	

3	Structure

Components of the module

No.	Curriculum Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Supplementary lecture in Computer Science	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials for the supplementary lecture in Computer Science	P	30 (2 contact hours)	30
3	Lecture	Lecture	Supplementary lecture in Computer Science	WP	45 (3 contact hours per week)	15
4	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials for supplementary lecture Computer Science	WP	15 (1 contact hour)	30

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 20- to 30-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules .	90–120 min.	1 or 3	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	The course requirements will be announced in good time and in an appropriate manner at the start of the modules. As a rule, this involves completing exercise tasks and presenting and discussing the results to an extent specified by the lecturer.	Weekly assignment sheets (1–2 pages in length), presentation and discussion: 5–10 minutes per candidate	2 or 4

5	Allocation of workload

Attendance (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1.5 credits
	Course No. 4	0.5 credits
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	2 credits
Total credits		5 ECTS

The module's workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Irregular	
Person responsible for module/department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science Department 14 – Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a specialisation in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Selected Topics in Computer Science (small) B
English translation of the module components from field 3	Course No. 1: Lecture on Selected Topics in Computer Science
	Course No. 2: Recitation Sessions on "Selected Topics in CS"
	Course No. 3: Lecture on Selected Topics in Computer Science
	Course No. 4: Recitation Sessions on "Selected Topics in CS"

9	**Miscellaneous**
	If courses from other degree programmes are offered as part of this module, the relevant examination regulations in their current version shall apply to the registration and withdrawal procedures, compulsory attendance and

	and passing the coursework and examinations. Admission to the examination is conditional upon the successful completion of the coursework.

degree programme	Data science (M.Sc.)
Modules	Supplementary Module in Computer Science (extended) A
Module number	DSM-MI-326

1	**Basic data**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**
Aims of the module/integration into the curriculum	
The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must totalling 30 ECTS credits must be completed.	
content of teaching	
A current or classic topic from the field of computer science (e.g. from the Institute of Computer Science, the Institute of Geoinformatics) with a connection to data science is presented in the lecture and explored in greater depth in the tutorials (in connection with the lecture/seminar). These modules serve to integrate courses into the curriculum that can only be offered once or on an irregular basis, e.g. because the lecturer is not permanently available. The specific content covered can be found in the announcement for the respective course in the course catalogue.	
Learning outcomes	
Students ... ... have an in-depth understanding of the subject area, including advanced methods, theoretical approaches and current research questions. ... are able to critically analyse original academic literature and develop their own research questions within the subject area. ... are able to independently apply concepts and techniques from the subject area to new and complex problems. ... can contextualise, reflect on and present and discuss results in an academic format.	

3	**Structure**					
Components of the module						
No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)

1	Lecture	Lecture	Supplementary lecture in Computer Science	P	60 (4 contact hours per week)	120
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials for the supplementary lecture in Computer Science	P	30 (2 contact hours per week)	90
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 20- to 30-minute oral examination instead of a written examination; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	120-180 min.	1	100%
Weighting of the module mark in the overall mark			8.70%		

Coursework				
No.	Type	Duration/scope		if applicable Organisational link to course No.
1	The course requirements will be announced in good time and in an appropriate manner at the start of the modules. As a rule, this involves completing exercise tasks as well as presenting and discussing the results to an extent specified by the lecturer.	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate		2

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	2 credits
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	3 credits

Examination performance (and self-study)	Exam No. 1	4 credits
Total credits		10 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Irregular	
Person responsible for module/department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science Department 14 – Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a specialisation in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Selected Topics in Computer Science (large) A
English translation of the module components from field 3	Course No. 1: Lecture on Selected Topics in Computer Science
	Course No. 2: Recitation Sessions on "Selected Topics in CS"

9	**Miscellaneous**
	If courses from other degree programmes are offered as part of this module, the relevant examination regulations in their current version shall apply to registration and withdrawal procedures, compulsory attendance, and participation in and passing of coursework and examinations. Admission to the examination is conditional upon the successful completion of the coursework.

degree programme	Data Science (M.Sc.)
Modules	Supplementary Module in Computer Science (extended) B
Module number	DSM-MI-327

1	**Basic data**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

A current or classic topic from the field of computer science (e.g. from the Institute of Computer Science, the Institute of Geoinformatics) with a connection to data science is presented in the lecture and explored in greater depth in the tutorials (in connection with the lecture/seminar).
These modules serve to integrate courses into the curriculum that can only be offered once or on an irregular basis, e.g. because the lecturer is not permanently available. The specific content covered can be found in the announcement for the respective

course in the course catalogue.

Learning outcomes

Students ...
... have an in-depth understanding of the subject area, including advanced methods, theoretical approaches and current research questions.
... are able to critically analyse original academic literature and develop their own research questions within the subject area.
... are able to independently apply concepts and techniques from the subject area to new and complex problems.
... can contextualise, reflect on and present results in an academic format, and

discuss them.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Supplementary lecture in Computer Science	P	60 (4 contact hours per week)	120

2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on Supplementary Lecture in Computer Science	P	30 (2 contact hours per week)	90
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 20- to 30-minute oral examination instead of a written examination; this change to the examination format will be announced in a suitable manner in good time at the start of the modules .	120–180 min.	1	100%
Weighting of the module mark in the overall mark			8.70%		
Coursework					
No.	Type		Duration/scope	Organisational details (if applicable) Link to course No.	
1	The course requirements will be announced in good time and in an appropriate manner at the start of the modules. As a rule, this involves completing practice exercises and presenting and discussing the results to an extent specified by the lecturer.		Weekly assignment sheets (1–2 pages in length), presentation and discussion: 5–10 minutes per student	2	

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	2 credits
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	3 credits
Examination performance (and self-study)	Exam No. 1	4 credits
Total LP		10 credits
The modules' workload is expressed in credit points. Please note: • The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.		

- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Irregular	
Person responsible for module/department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science Department 14 – Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a specialisation in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Selected Topics in Computer Science (large) B
English translation of the module components from field 3	Course No. 1: Lecture on Selected Topics in Computer Science
	Course No. 2: Recitation Sessions on "Selected Topics in CS"

9	**Miscellaneous**
	If courses from other degree programmes are offered as part of this module, the relevant examination regulations in their current version shall apply to registration and withdrawal procedures, compulsory attendance, and participation in and passing of coursework and examinations. Admission to the examination is conditional upon the successful completion of the coursework.

degree programme	Data Science (M.Sc.)
Modules	Human Computer Interaction
Module number	DSM-MI-328

1	**Basic information**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

The Human-Computer Interaction (HCI) course teaches fundamental concepts and methods for the design and evaluation of interactive systems. Students gain a sound understanding of the principles of human interaction with technology and learn to develop user-friendly interactive systems and systematically evaluate their usability.

The course consists of a 90-minute lecture and a 90-minute tutorial (in connection with lecture/seminar) per week and is divided into four thematic areas:

- Fundamentals of HCI and the psychology of human interaction,
- Design of interactive systems,
- Evaluation of the usability of interactive systems,
- Relevant case studies from human-computer interaction.

In the accompanying practical tutorials, students apply the theoretical content in practice, develop their own design solutions and evaluate these using established criteria. Assessment takes place via a portfolio, with a graded submission for each of the four

subject areas.

Learning outcomes

Students ...
... understand key concepts of human-computer interaction as well as the psychological foundations of human information processing,
... can apply principles and methods of design and evaluation of interactive systems to develop user-friendly technologies,
... and are able to systematically evaluate the usability of interactive systems and transfer design solutions to new application contexts.
Overall, students thus acquire, through real-world problem-solving, skills in

working independently and with methodological depth within a clearly defined specialist area of (geo-)informatics.

3	Structure

Components of the module

No.	Specification Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Human-Computer Interaction	P	30 (2 contact hours)	30
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Human-Computer Interaction"	P	30 (2 contact hours)	60

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course, if applicable No.	Weighting Module mark
1	MAP	Final module assessment in the form of a portfolio comprising four topic-based assignments spread across the semester. These consist of written or graphical reports (2–5 pages) and/or presentations (5–15 minutes) on the content of (1) and (2). Note on the examination format: If there are a large number of participants, a written examination (60–90 minutes) may be held as an alternative. Any change to the examination format will be announced in good time at the start of the modules .	A total of 4 assignments of 2–5 pages or lecture recordings of 5–15 minutes In the case of an exam: 60–90 minutes	1	100%

Weighting of the module mark towards the final mark	4.35%

Coursework

No.	Type	Duration/scope	Organisational link to course, if applicable No.
1	None		

5	Allocation of the workload	
Attendance (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
Coursework (and self-study)		
Examination performance (and self-study)	PL No. 1	3 credits
Total credits		5 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- The workload for the portfolio tasks is designed to take a total of approx. 60 hours (2 credits). The sub-tasks include, amongst other things, independent study of specialist literature, the preparation of presentations, practical tasks such as the evaluation of a mock-up, and the corresponding documentation.
- If time has been allocated for self-study (e.g. preparation for and follow-up on lectures, etc.) that is not directly related to examination or coursework, this is nevertheless counted towards the module's requirements.
- The credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examinations and coursework that the

  learning outcomes have been acquired.

6	Prerequisites	
Module-specific entry requirements	None	
Attendance policy	Attendance at courses is strongly recommended.	

7	Modules schedule	
Frequency/Schedule	in the summer semester	
Person responsible for module/department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 14 – Earth Sciences

8	Mobility/Recognition	
Applicability to other degree programmes	Geoinformatics and Data Science (M.Sc.), Geospatial Technologies (M.Sc.)	
Module language(s)	English	
Module title in English	Human Computer Interaction	
English translation of the module components from field 3	Course No. 1: Human Computer Interaction	
	Course No. 2: Recitation Sessions on "Human Computer Interaction"	

9	Miscellaneous
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degree programme	Data Science (M.Sc.)
Modules	Inverse Problems and Computer Vision
Module number	DSM-MI-329

1	**Prerequisites**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules form part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. The modules are designed to introduce students to current research trends in the field of modelling and simulation. Successful completion of the modules provides the academic foundation required to write a Master's thesis in a field of applied mathematics.

content of teaching

Methods from the field of mathematical modelling and the simulation of mathematical models, as well as their application.
(The content may vary significantly depending on the choice of courses.)

Learning outcomes

Students will have acquired a selection of the following skills. They

- are familiar with a problem-specific selection of modelling approaches,
- are familiar with a problem-specific selection of numerical methods,
- can analyse these models and methods and prove their properties,
- are able to evaluate the suitability of various methodological approaches in relation to specific problems,
- have developed their programming skills and
- are able to implement advanced numerical methods independently.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Inverse problems and Computer Vision	P	60 (4 contact hours)	150

2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Inverse problems and Computer Vision"	P	30 (2 contact hours)	60

Options within the modules:

As a rule, a lecture with a tutorial (in connection with a lecture/seminar) worth 10 ECTS credits should be selected from the field of "Modelling and Simulation", for example:

- Inverse Problems
- Theory of Non-linear Optimisation
- Numerical Optimisation (in Machine Learning)
- Theory of Inverse Problems
- Mathematics of Computer Vision

Alternatively, students may also take a seminar and a further course (lecture, practical, etc.) totalling 10 ECTS credits.

The module coordinator may approve further courses with a suitable subject focus; these will then be marked in the course catalogue.

Important: No courses may be selected whose content overlaps with courses that have already been credited during the Bachelor's phase or in another module of the data science master course.

4 Examination structure

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written or oral examination covering the lecture and the tutorials (in connection with a seminar). Alternatively, a seminar paper may be set. Any changes to the examination format will be announced in a timely manner at the start of the modules.	120–180 min. written exam or 30 min. oral exam or term paper 10–20 pp.	1	100%

Weighting of the module mark towards the overall mark	8.70%

Coursework

No.	Type	Duration/scope	Organisational link to course, if applicable No.
1	Completion of tutorial tasks and project tasks; this includes presentation and discussion of the results.	Weekly assignment sheets (1–2 pages in length), presentation and discussion: 5–10 minutes per candidate	2

5	Allocation of workload	
Attendance (contact hours)	Course No. 1	2 credits
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	5 ECTS
Examination performance (and self-study)	Exam No. 1	2 credits
Total credits		10 ECTS

The workload of the module is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	Prerequisites
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	At least every winter semester, usually every semester.	
Person responsible for module	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	Mobility/Recognition
Applicability to other degree programmes	Mathematics (M.Sc.); Computer Science (M.Sc.)
Module language(s)	English
Module title in English	Inverse Problems and Computer Vision
English translation of the module components from Field 3	Course No. 1: Lecture Inverse Problems and Computer Vision
	Course No. 2: Tutorial on “Inverse Problems and Computer Vision”

9	Other
	Knowledge of programming in Python, as well as knowledge of basic numerical methods for solving linear and non-linear systems of equations, is strongly recommended.

	This module provides important foundations recommended for a Master’s thesis in the field of numerical mathematics.

degree programme	Data Science (M.Sc.)
Modules	Computer Science Seminar
Module number	DSM-MI-330

1	**Basic data**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules form part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. The Computer Science Seminar module specifically promotes students' abilities to engage with academic literature, to present complex computer science content appropriately in both written and oral form, and to discuss complex computer science issues. It thus serves as important preparation for the

Master's thesis and can also prepare students for this in terms of content.

content of teaching

The course organiser, usually a lecturer from the field of computer science (e.g. the Institute of Computer Science, the Institute of Geoinformatics), selects an area of computer science for the seminar and compiles a series of topics from this area to be covered in the seminar. For each topic, they select one or more original articles. Each student chooses one of these topics and, using the original literature provided, familiarises themselves with the given topic largely independently. In doing so, they critically engage with the content of the original literature and research and study further literature that is necessary for understanding or that rounds off their understanding. In a written paper, the participant presents an overview of the topic in their own words and presents and discusses the topic in a lecture to the other students and the seminar supervisors. They attend the lectures given by the other students and actively participate in the discussions on the other topics.

When familiarising themselves with the topic, writing the paper and preparing the presentation, participants are supported by a supervisor from the working group of the respective course organiser. At the discretion of the respective course organiser, a seminar may also include additional components introducing academic research methods. Depending on the topic, participants may also be required to

.

Learning outcomes

Students ...
… learn to familiarise themselves largely independently with a challenging academic topic in the field of computer science,
… critically engage with the content of academic publications and research and obtain the necessary literature.
… learn to present complex academic computer science content appropriately in written and oral

and discuss such content in a professional manner.

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Seminar	Seminar	Computer Science Seminar	P	30 (2 contact hours per week)	120

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Seminar presentation and seminar paper	30–45 min. presentation, 10–20-page paper	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	None		

5	Allocation of workload

Attendance (contact hours)	Course No. 1	1 credit
Coursework (and self-study)		
Examination requirements (and self-study)	Course No. 1	4 credits
Total credits		5 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module will only **be awarded** once the module has been

  has been successfully completed, i.e. by passing all examinations and

academic requirements	have been demonstrated	,	that	the	the	modules	have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every semester	
Person responsible for module/Department	The current module coordinators can be found at https://uni.ms/datascience-mv .	Department 10 – Mathematics and Computer Science; Department 14 - Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Computer Science Seminar
English translation of the module components from field 3	Course No. 1: Computer Science Seminar

9	**Other**
	–

degree programme	Data Science (M.Sc.)
Modules	Mathematical Statistics and its Applications
Module number	DSM-MI-331

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective section of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. The modules are designed to introduce students to current research trends in the field of

mathematical statistics. Successful completion of the module provides the academic foundation required to write a Master's thesis in a field of mathematical

statistics.

content of teaching

Mathematical Statistics and its Applications
(The content may vary significantly depending on the choice of courses.)

Learning outcomes

Students will be able to ...
... explain key concepts and results in mathematical statistics.
... apply statistical methods to real and simulated data.
... analyse and evaluate the strengths and limitations of various methods.
... understand and contextualise research in mathematical statistics.
... select and use appropriate statistical tools to solve specific problems.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Statistics and its applications	P	60 (4 contact hours per week)	150
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on 'Statistics and its Applications'	P	30 (2 contact hours)	60

Options within the modules:

As a rule, one lecture should be selected from the following list of courses: Statistics II
Non-parametric Statistics
High-dimensional statistics/statistics on manifolds Random matrix theory
Statistical Methods of Pattern Recognition Statistical Learning Theory
Time Series
The module coordinator may approve further courses with a suitable subject focus; these will then be marked in the course catalogue.

Important: You may not select courses whose content overlaps with courses that have already been credited during the Bachelor's phase or in another module of the data science master course.

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written or oral examination covering the lecture and the tutorials If there are few participants, the examiner may offer a 30-minute oral examination instead of a written exam; this change in the examination format will be announced in a suitable manner in good time at the start of the modules.	120–180 min	1	100%
Weighting of the module mark towards the overall mark			8.70%		

Coursework			
No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Completion of tutorial and project tasks to a scope specified by the lecturer, which will be announced at the start of the course; this includes the presentation and discussion of the results	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	**Allocation of workload**	
Participation (contact hours)	Course No. 1	2 credits
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	5 ECTS
Examination performance (and self-study)	Exam No. 1	2 credits

Total credits		10 ECTS

The workload of the module is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Every winter semester	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	**Mobility/Recognition**
Applicability to other degree programmes	Mathematics (M.Sc.)
Module language(s)	English
Module title in English	Specialisation in Probability and its Applications
English translation of the module components from Field 3	Course No. 1: Lecture on Specialisation in Probability and its Applications
	Course No. 2: Tutorial on “Specialisation in Probability and its Applications”

9	**Other**
	Knowledge of the fundamentals of statistics and probability theory is strongly recommended. This module provides important groundwork recommended for a Master’s thesis in the field of Mathematical Statistics. The frequency of these modules, as stated under 7, is subject to sufficient teaching capacity and sufficient demand.

degree programme	Data Science (M.Sc.)
Modules	Modelling and Simulation
Module number	DSM-MI-332

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective section of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. The module is designed to introduce students to current research trends in the field of modelling and simulation. Successful completion of the module provides the academic foundation required to write a Master's thesis in a field of applied data science

mathematics.

content of teaching

Methods from the field of mathematical modelling and the simulation of mathematical models, as well as their application.
(The content may vary significantly depending on the choice of courses.)

Learning outcomes

Students have acquired a selection of the following skills. They

- are familiar with a problem-specific selection of modelling approaches,
- are familiar with a problem-specific selection of numerical methods,
- can analyse these models and methods and prove their properties,
- are able to evaluate the suitability of various methodological approaches in relation to specific problems,
- have developed their programming skills and
- are able to implement advanced numerical methods independently.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Modelling and Simulation	P	60 (4 contact hours)	150
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on 'Modelling and Simulation'	P	30 (2 contact hours)	60

Options within the modules:
As a rule, students should select a lecture and tutorial (in connection with a seminar) worth 10 ECTS credits from the field of 'Modelling and Simulation', for example: • Mathematical Modelling • Modern applied mathematics in bioelectromagnetics • Numerical methods for partial differential equations • Scientific Computing • Scientific Machine Learning Alternatively, a seminar and a further course (lecture, practical, etc.) totalling at least 10 ECTS credits may be taken. The module coordinator may approve further courses with a suitable subject focus; these will then be marked in the course catalogue. Important: You may not select courses whose content overlaps with courses that have already been credited during the Bachelor's phase or in another module of the data science master course.

4	**Examination structure**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written or oral examination covering the lecture and the associated tutorials (in connection with the seminar). Alternatively, a seminar paper may be set. Any changes to the examination format will be announced in a suitable manner in good time at the start of the modules.	120–180 min. written exam or 30 min. oral exam or term paper of 10–20 pages	1	100%
Weighting of the module mark towards the overall mark			8.70%		
Coursework					
No.	Type		Duration/scope	Organisational link to course No. (if applicable)	
1	Completion of tutorial and project tasks; this includes presentation and discussion of the results.		Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2	

5	**Allocation of workload**	
Participation (contact hours)	Course No. 1	2 credits
	Course No. 2	1 credit

Coursework (and self-study)	SL No. 1	5 ECTS
Examination performance (and self-study)	Exam No. 1	2 credits
Total credits		10 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	At least every winter semester, usually every semester.	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Faculty 10 – Mathematics and Computer Science

8	**Mobility/Recognition**
Applicability to other degree programmes	Mathematics (M.Sc.); Computer Science (M.Sc.)
Module language(s)	English
Module title in English	Modelling and Simulation
English translation of the module components from field 3	Course No. 1: Lecture on Modelling and Simulation
	Course No. 2: Tutorial on "Modelling and Simulation"

9	**Miscellaneous**
	Knowledge of programming in Python, as well as knowledge of basic numerical methods for solving linear and non-linear systems of equations, is strongly recommended. This module provides important foundations recommended for a Master's thesis in the field of numerical mathematics.

degree programme	Data Science (M.Sc.)
Modules	IoT in data science
Module number	DSM-MI-333

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

This module forms part of the compulsory elective component of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits.

Students acquire skills in the design, implementation and analysis of IoT-based systems. They are able to collect sensor data in a targeted manner, transmit it via suitable networks and process it in digital twins using data-driven methods. Furthermore, they develop the ability to implement such systems in practice and to utilise their data in data science applications within the context of digital twins – particularly with regard to ongoing

projects, specialisation modules or final theses in the field of IoT and data science.

content of teaching

In this module, students are introduced to the fundamental concepts and technologies of the Internet of Things (IoT), with a particular focus on sensor-based data acquisition, communication and data processing, as well as the integration of data into networked systems. They learn to analyse the hardware and software components of IoT systems, which consist of microcontrollers, sensors and actuators, to coordinate these functionally and to evaluate them in terms of their interactions. A practical component of the module deals with low-level programming and the use of sensors for collecting environmental data in sensor networks. In addition, students acquire knowledge in the development of digital twins to utilise sensor data for forecasts, visualisations and condition analyses. Students independently explore specific topics within the IoT, develop their own prototypes and reflect on current technological developments.

The content covered is documented in a written report, presented in a lecture and reflected upon during group discussions. Particular emphasis is placed on the structured presentation of technical content, critical engagement with technologies, and the ability to link theoretical knowledge with practical applications.

Alternatively, the content covered is assessed via an examination and put into practice as part of a programming project. Depending on the topic, this may involve the prototypical implementation of a simple IoT application or the creation of a digital twin. Students receive academic supervision throughout the entire process.

The seminar thus provides practical preparation for research- or project-oriented work in the field of

embedded systems and IoT.

Learning outcomes
Students … … understand the fundamental concepts of **data acquisition**, **communication** and **processing** in **IoT systems** and can integrate these into networked systems. … analyse **the hardware and software components** of an IoT system and understand how they interact. … are able to develop **digital twins**, integrate environmental data and use this for forecasting and condition analysis. … independently explore topics in **physical computing and IoT**, present technical content in a manner appropriate to the target audience, and implement technological concepts in prototype applications. … thereby acquire the skills to develop and critically reflect on them.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Seminar	Seminar	Physical Computing and Sensors on the IoT	WP	30 (2 contact hours)	120
2	Seminar	Seminar	3D Models and IoT-enabled Digital Twins	WP	60 (4 contact hours)	90

Options within the modules:

Students choose Seminar 1 or 2.

4	**Examination format**

Assessment

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Seminar presentation and poster	The presentation lasts 45–80 minutes; the poster is in A0 or A1 format.	1	100%
or					
2	MAP	Written exam	The exam lasts 30–60 minutes.	2	100%
Weighting of the module mark towards the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational links, if applicable to T&C No.
1	Completing practice exercises	Weekly worksheets or 2–3 larger assignments equivalent in scope to the weekly worksheets.	2

5	Allocation of workload	
Attendance (attendance or contact time)	Course No. 1	1 credit
	Course No. 2	2 credits
Coursework (and self-study)	SL No. 1	1
Examination performance (and self-study)	PL No. 1	4 credits
	PL No. 2	2 credits
Total credits		5 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the credits.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes assigned to the module have been acquired.

6	Prerequisites
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Usually every semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 14 Earth Sciences

8	Mobility/Recognition	
Applicability to other degree programmes	Geoinformatics and Data Science (M.Sc.), Geospatial Technologies (M.Sc.)	
Module language(s)	English	
Module title in English	IoT in data science	
English translation of the module components from Field 3	Course No. 1: Physical Computing and Sensors on the IoT	
	Course No. 2: 3D Models and IoT-enabled Digital Twins	

9	Other
	None.

degree programme	Data Science (M.Sc.)
Modules	Spatial Data Science with R
Module number	DSM-MI-334

1	**Prerequisites**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules form part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. The seminar *'Spatial Data Science with R'* imparts fundamental skills in the analysis, processing and visualisation of spatial data using the R programming language. Students independently explore current methods and fields of application in spatial data analysis and present these in a scientifically sound and practical manner. The seminar thus lays the foundation for research- or project-oriented work in the fields of

data science and geoinformatics.

content of teaching

In the seminar, students explore methods of spatial data analysis using the R programming language. Key concepts and tools for the collection, processing, analysis and visualisation of geodata are covered, including working with vector and raster data, spatial statistics and the integration of external geodata sources (e.g. OpenStreetMap, satellite data, geodata services). In addition, the seminar covers fundamental principles and best practices for working with open-source software, particularly with regard to reproducibility, documentation and collaborative development.

Students choose a thematic sub-area that addresses a specific methodological or application-oriented aspect of spatial data science – such as location analysis, spatial regression models, mobility data or environmental modelling. The independent project involves systematic familiarisation with the subject area, testing relevant R packages (e.g. *sf*, *stars*, *terra*, *tmap*, *ggplot2*), a written report and a presentation of the results, including in the form of a self-created R package.

In addition to imparting specialist knowledge, particular emphasis is placed on the reflective selection of suitable methods, the clean implementation of reproducible

workflows in R, and the structured presentation of analysis results. Students are supervised throughout the entire project process.

Learning outcomes
Students … … understand fundamental concepts of spatial data analysis and can confidently classify and use typical geodata formats and sources, … are proficient in the practical use of relevant R packages for the processing, analysis and visualisation of spatial data, … are able to understand, select, apply and critically reflect on suitable methods for specific questions in the field of spatial data science, … can document and present their results in a reproducible format, taking into account open-source best practices, including through the creation of an R package, … and have the ability to present complex analytical content in writing and and put them up for discussion.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Seminar	Seminar	Spatial Data Science with R	P	60 (4 contact hours)	90

Options within the modules:
None

4	**Examination format**

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Portfolio comprising self-developed software and documentation, as well as a reproducible sample application	The submission consists of two elements (weighting 50/50): 1) Self-developed R package 2) Vignette for the R package	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	None		

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	2 credits
Coursework (and self-study)		
Examination requirements (and self-study)	Course No. 1	3 credits
Total credits		5 credits

The module's workload is expressed in credit points. Please note: • The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance. • If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the credits. • Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes assigned to the module have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance regulations	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every other semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 14 Earth Sciences

8	**Mobility/Recognition**
Applicability to other degree programmes	Geoinformatics and Spatial Data Science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Spatial Data Science with R
English translation of the module components from field 3	Course No. 1: Spatial Data Science with R

9	**Other**
	–

degree programme	Data Science (M.Sc.)
Modules	Statistical Relational Artificial Intelligence
Module number	DSM-MI-335

1	**Prerequisites**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

The module provides an insight into the research field of Statistical Relational Artificial Intelligence (StaRAI), which is characterised by statistical or probabilistic models in combination with relational structures. Problems, their mathematical background and methods for solving them are covered, and their practical application is discussed using small examples. In the tutorials (in connection with lecture/seminar), the concepts are explored in greater depth and discussed comparatively. Possible topics include exact and approximate probabilistic inference and decision-making in probabilistic relational models and relational

learning methods.

Learning outcomes

Students will ...
... understand the fundamentals of probabilistic inference in relational models as well as their theoretical formalisation,
... can evaluate different formalisms and solution methods and select them appropriately for specific problems,
… can apply these to new problems and evaluate them appropriately,

…and thus learn to work independently and with methodological depth in the field of artificial intelligence.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Statistical Relational Artificial Intelligence	P	45 (3 contact hours)	60

2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Statistical Relational Artificial Intelligence"	P	15 (1 contact hour)	30
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Oral examination on (1) and (2). If there are a large number of participants, the examiner may set a 90- to 120-minute written examination instead of an oral examination; this change to the examination format will be announced in the first module appropriate form.	20–40 min.	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework			
No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving practice problems, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	**Allocation of workload**	
Attendance (attendance or contact time)	Course No. 1	1.5 credits
	Course No. 2	0.5 credits
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	2 credits
Total credits		5 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the module.

- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every 2 years	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv .	Department 10 – Mathematics and Computer Science

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a focus on Computer Science)
Module language(s)	English
Module title in English	Statistical Relational Artificial Intelligence
English translation of the module components from field 3	Course No. 1: Statistical Relational Artificial Intelligence
	Course No. 2: Recitation Sessions on "Statistical Relational Artificial Intelligence"

9	**Miscellaneous**
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Visual Analytics
Module number	DSM-MI-336

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**
Aims of the module/integration into the curriculum	
This module forms part of the compulsory elective component of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must totalling 30 ECTS credits must be completed.	
content of teaching	
This module covers the theoretical and practical foundations of visual analytics. Visual analytics deals with analytical reasoning supported by interactive visual representations. It combines the strengths of automated data analysis with the human ability to quickly identify patterns or trends visually.	
Learning outcomes	
Students ... ... have a firm grasp of the fundamental concepts and algorithms of visual analytics and are able to apply them correctly.	

3	**Structure**					
Components of the module						
No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Visual Analytics	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Visual Analytics"	P	30 (2 contact hours)	30
Options within the modules:						
None						

4	**Examination format**
Examination component(s)	

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 20- to 30-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules.	120-180 min.	1	100%
Weighting of the module mark in the overall mark			58.70%		

Coursework

No.	Type	Duration/scope	Organisational details (if applicable) Link to course No.
1	Completing practice exercises, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion: 5–10 minutes per candidate	2

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	Exam No. 1	2 credits
Total credits		5 ECTS

The module's workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance regulations	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Usually every year in the winter semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	Mobility/Recognition
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Visualisation
English translation of the module components from field 3	Course No. 1: Visual Analytics
	Course No. 2: Recitation Sessions on "Visual Analytics"

9	Miscellaneous
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Visualisation
Module number	DSM-MI-304

1	**Basic information**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module forms part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. To this end, this module may be taken as part of the compulsory elective area within the core data science module. Students must complete modules totalling 5 ECTS credits from this area (modules DSM-MI-30x).

content of teaching

The lecture provides an introduction to the field of visualisation within the subject area of computer graphics. It covers the fundamentals of interactive visual data analysis and its concepts, and delves into the methodology of various visualisation mechanisms. The following areas are covered:

(1) Scientific visualisation, in particular methods for visualising scalar, vector and tensor fields.
(2) Information visualisation, in particular methods for visualising abstract, multidimensional data and relations.
(3) Visual analytics.

In the tutorials held in connection with the lecture/seminar, the algorithms presented are explored in greater depth, tested in practice and implemented. The basics of graphics programming are taught as far as necessary.

Learning outcomes

Students
... will acquire introductory knowledge of the fundamental concepts and algorithms of visualisation, as well as practical experience.
... learn, understand and apply methods of scientific visualisation for scalar, vector and tensor fields, methods of information visualisation for abstract, multidimensional data, and principles of visual analytics to interactively explore and interpret them.

... implement basic visualisation algorithms and apply them to real-world datasets.
... analyse different visualisation approaches in terms of their suitability for specific tasks in visual data analysis.

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Visualisation	P	60 (4 contact hours)	120
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Visualisation"	P	30 (2 contact hours)	90

Options within the modules:

None

4	Examination format

Examination(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 20- to 30-minute oral examination instead of a written exam; this change to the examination format will be announced in a suitable manner in good time at the start of the modules .	120–180 min.	1	100%

Weighting of the module mark in the overall mark	8.70%

Coursework

No.	Type	Duration/scope	Organisational details (if applicable) Link to course No.
1	Completing exercises, presentation and discussion of results	Weekly exercise sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	Allocation of workload

Attendance (contact hours)	Course No. 1	2 credits
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	3 credits

Examination performance (and self-study)	Exam No. 1	4 credits
Total credits		10 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Usually every year in the winter semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	**Mobility/Recognition**
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Visualisation
English translation of the module components from field 3	Course No. 1: Visualisation
	Course No. 2: Recitation Sessions on "Visualisation"

9	**Miscellaneous**
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Visualisation Specialisation
Module number	DSM-MI-337

1	**Entry requirements**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules are part of the compulsory elective area of the Mathematical and Computational Data Science specialisation within the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must

totalling 30 ECTS credits must be completed.

content of teaching

The lecture provides in-depth knowledge in the field of visualisation. Possible topics include advanced methodologies in scientific visualisation, information visualisation and/or visual analytics, as well as the interactive visual analysis of data with specific characteristics, such as medical visualisation.

In the tutorials (in connection with the lecture/seminar) presented, the algorithms presented are explored in depth, tested in practice and implemented.

Learning outcomes

Students
... acquire advanced knowledge in the field of visualisation, particularly regarding topics in scientific visualisation, information visualisation or visual analytics, and the ability to apply this knowledge in practice.
... design interactive visualisation processes for exploratory analysis and critically interpret their results.
... analyse complex visualisation tasks and select suitable specialised methods and algorithms to solve them.
... develop their own implementations of advanced visualisation techniques and evaluate

their effectiveness using real-world data.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Visualisation Advanced	P	45 (3 contact hours)	60

2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Advanced Visualisation"	P	15 (2 contact hours)	30
Options within the modules:						
None						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written examination on (1) and (2) If there are few participants, the examiner may offer a 20- to 30-minute oral examination instead of a written examination; this change to the examination format will be announced in good time at the start of the modules in an appropriate .	90–120 min	1	100%
Weighting of the module mark in the final mark			4.35%		

Coursework			
No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving exercises, presentation and discussion of results”	Weekly exercise sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	**Allocation of workload**	
Attendance (attendance or contact time)	Course No. 1	1.5 credits
	Course No. 2	0.5 credits
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	2 credits
Total credits		5 ECTS

The workload of the module is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the coursework.
- The credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the learning outcomes assigned to the module

  learning outcomes have been achieved.

6	Prerequisites
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Usually every 2 years in the winter semester	
Person responsible for module/department	The current module coordinators can be found at https://uni.ms/datascience-mv.	Faculty 10 – Mathematics and Computer Science

8	Mobility/Recognition
Applicability to other degree programmes	Computer Science (M.Sc.); Mathematics (M.Sc., with a minor in Computer Science); Geoinformatics and data science (M.Sc.), Geospatial Technologies (M.Sc.)
Module language(s)	English
Module title in English	Advanced Visualisation
English translation of the module components from field 3	Course No. 1: Advanced Visualization
	Course No. 2: Recitation Sessions on "Advanced Visualization"

9	Miscellaneous
	Admission to the examination is conditional upon the completion of coursework.

degree programme	Data Science (M.Sc.)
Modules	Probability Theory and its Applications
Module number	DSM-MI-360

1	**Basic information**
Subject related semester	1st, 2nd or 3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The modules form part of the compulsory elective area within the Mathematical and Computational Data Science specialisation of the data science degree programme. Students who have chosen the Computational and Mathematical Data Science specialisation must complete modules totalling 30 ECTS credits. The modules are designed to introduce students to current research trends in the field of probability theory. Successful completion of the modules provides the academic foundation required to write a Master's thesis in a specific area of probability theory.

content of teaching

Probability theory and its applications
(The content may vary significantly depending on the choice of courses.)

Learning outcomes

Students will be able to ...
... describe and explain key concepts and theorems of probability theory.
... apply advanced probabilistic methods and solve complex problems.
... analyse current research.
... formulate precise research questions and devise solution strategies.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Probability theory and its applications	P	60 (4 contact hours per week)	150
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Probability Theory and its Applications"	P	30 (2 contact hours)	60

Options within the modules:
As a rule, one lecture should be selected from the following list of courses: • Probability Theory II • Probability Theory III • Theory of Large Deviations • Extreme Value Theory • Reinforcement Learning • Stochastic Analysis • Information Theory • Stochastic geometry The module coordinator may approve further courses with a suitable subject focus; these will then be marked in the course catalogue. Important: You must not select courses whose content overlaps with courses that have already been credited during the Bachelor's phase or in another module of the master course in data science.

4	**Examination structure**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Written or oral examination covering the lecture and the tutorials Any change to the examination format will be announced in good time at the start of the modules appropriate manner.	120–180 min. written exam or 30 min. oral exam	1	100%
Weighting of the module mark in the final mark			8.70%		
Coursework					
No.	Type		Duration/scope		Organisational link to course, if applicable No.
1	Completing exercises, presentation and discussion of results		Weekly assignment sheets (1–2 pages in length), presentation and discussion: 5–10 minutes per candidate		2

5	**Allocation of workload**	
Participation (attendance or contact time)	Course No. 1	2 credits
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	5 ECTS

Examination performance (and self-study)	Exam No. 1	2 credits
Total credits		10 ECTS

The workload of the module is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Every winter semester	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 10 – Mathematics and Computer Science

8	**Mobility/Recognition**
Applicability to other degree programmes	Mathematics (M.Sc.)
Module language(s)	English
Module title in English	Specialisation in Probability and its Applications A
English translation of the module components from field 3	Course No. 1: Lecture 1 on Specialisation in Probability and its Applications A
	Course No. 2: Tutorial on Specialisation in Probability and its Applications A

9	**Other**
	Knowledge of the fundamentals of probability theory and statistics is strongly recommended. This module provides important foundations that are strongly recommended for a Master's thesis in the field of probability theory. The course schedule for this module, as indicated under 7, is subject to sufficient teaching capacity and sufficient demand.

Specialisation: Data Science in Chemistry

degree programme	**MSc data science**
Modules	Theoretical Chemistry
Module number	DSM-CH-400

1	**Basic information**
Subject related semester	1 (course start in the winter semester) or 2 (course start in the summer semester)
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

In the first year of the M.Sc. data science degree programme with a specialisation in data science in Chemistry, this module, offered in the winter semester, builds on the knowledge gained in the Bachelor's degree programme in Chemistry (or closely related programmes). Students gain an insight into various quantum chemical approximation methods and simulation techniques, and learn to describe complex chemical phenomena theoretically. Practical work on the computer helps students to apply this new knowledge to specific problems in Chemistry.

content of teaching

The lecture is divided into a quantum chemistry section and a modelling section with corresponding applications. The following aspects, among others, are covered:

— Systematic introduction to fundamental approximation methods in quantum chemistry

— Wavefunction methods for describing the electronic structure of molecular systems (Hartree–Fock theory, configuration interaction, many-body perturbation theory, coupled-cluster theory, hybrid methods)
- Fundamentals and practical approximations of density functional theory

— Calculation of thermodynamic properties, reaction mechanisms and spectroscopic data.

— Modelling using molecular dynamics simulations.

— Theoretical models for describing phenomena in physical chemistry.

— Theoretical understanding of dynamic processes.

In a practical session held immediately afterwards, these topics are explored in greater depth through practical and, where appropriate, individually tailored computer-based tasks. In doing so, students become familiar with a wide range of

different theoretical methods and simulation techniques.
Learning outcomes
Students are able to select the optimal theoretical methods for their individual research questions and carry out corresponding calculations that meet modern scientific standards. In particular, they possess the theoretical tools to write a Master's thesis in the field of theory, but are equally qualified to provide a theoretical foundation for subsequent experimental/synthetic work through the use of suitable software. Furthermore, students can draw on the concepts they have learnt when addressing current issues in Theoretical Chemistry.

3	**Structure**					
Components of the module						
No.	Course Category	Course format	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Theoretical Chemistry	P	60 hours / 4 contact hours per week	90 hours
2	Practical	Experimental tutorials	Experimental tutorials	P	75 hours / 5 contact hours	75 hours
Options within the modules			None			

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	if applicable Link to course no.	Weighting Module mark
1	MTP	Oral examination: Quantum chemistry section	25 mins		50%
2	MTP	Oral examination: Modelling/Theory of Complex Systems	25 mins		50%
Weighting of the module mark in the overall mark		8.70%			
Coursework					
No.		Type	Duration/scope	if applicable Link to course no.	
1		Report on the Theoretical Chemistry Practical	5–10 pages	2	—

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	2 credits
	Course No. 2	2.5 credits
Coursework (and self-study)	No. 1	1.5 credits
	No. 1	2.0 credits

Examination performance (and self-study)	No. 2	2.0 credits
Total credits		10 credits

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for lectures, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the module.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examinations and coursework that the learning outcomes assigned to the module have been achieved

6	**Prerequisites**
Module-specific Entry requirements	A prerequisite for sitting the module examinations is the successful completion of the coursework
Attendance regulations	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Always in the second half of the winter semester	
Person responsible for module/Department	The current module coordinators can be found at https://uni.ms/datascience-mv .	Department 12 Chemistry and Pharmacy

8	**Mobility/Recognition**
Applicability to other degree programmes	–
Module language(s)	The modules are usually taught in English. They will only be taught in German if the students unanimously request this at the start of the course.
Module title in English	Theoretical Chemistry
English translation of the module components from field 3	Course No. 1: Lecture Theoretical Chemistry
	Course No. 2: Exercises

9	**Miscellaneous**
	–

degree programme	**MSc data science**
Modules	Data Science in Chemistry
Module number	DSM-CH-402

1	**Entry requirements**
Subject related semester	2 and 3 (course start in the winter semester) or 1 and 4 (course start in the summer semester)
Credit points (CP)	12
Total workload (hours)	360
Duration of the module	2 semesters
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

This module from the M.Sc. data science degree programme, specialising in data science in Chemistry, is designed to equip students with knowledge of which machine learning and data science concepts are relevant for applications in Chemistry. Students thus learn to apply suitable concepts for investigating complex chemical phenomena. Practical computer-based work helps students to gain a deeper understanding of this new knowledge. In addition, computer-based practicals in the field of 'Theoretical Chemistry' help to describe fundamental chemical phenomena using

using appropriate models and algorithms.

content of teaching

Lecture series (summer semester):
Research group leaders, who may come from any of the Chemistry teaching units within Faculty 12, will present their research, with a particular focus on how the skills acquired on this degree programme can be usefully applied. Where appropriate, visits to the research groups may also be arranged.

Chemistry / Theoretical Chemistry Practical (Winter Semester):
In a computer-based practical, topics from the 'Theoretical Chemistry' module are explored in greater depth through practical and, where appropriate, individually tailored computer-based tasks. The topics cover both quantum chemistry (using wave function methods and density functional theory) and classical modelling (using molecular dynamics and Monte Carlo simulation techniques).

Machine Learning in Chemistry (Winter Semester):

Here, various machine learning methods relevant to chemical problems are introduced. Both the underlying concepts and the specific applications are discussed. In an accompanying practical session, students learn to apply these methods in practice using provided Python scripts, for example to optimise hyperparameters. Computer workstations will be provided where necessary. Students meet with teaching staff at regular intervals to

discuss technical questions arising from the practical experiments.
Learning outcomes
Students … … are able to use optimal models from the field of data-driven methods (in particular machine learning) to address problems in Chemistry. … have knowledge of the areas of Chemistry in which data-driven methods are relevant. … are able to identify suitable algorithms for chemistry-related problems in the field of data-driven methods and implement them technically using Python.

3	**Structure**

Components of the module

No.	Course Category	Course format	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Lecture series	P	30 hours / 2 contact hours	30 hours
2	Practical	Computer practical	Practical in Theoretical Chemistry	P	60 hours / 4 contact hours	60 hours
3	Lecture	Lecture	Lecture on Machine Learning in Chemistry	P	45 hours / 3 contact hours	45 hours
4	Practical	Computer practical	Computer practical on machine learning in Chemistry	P	45 hours / 3 contact hours	45 h

Options within the modules	None

4	**Examination format**

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	if applicable Link to course no.	Weighting Module mark
1	MAP	Oral examination Machine Learning	30 mins		100%

Weighting of the module mark towards the overall mark	10.44%

Coursework

No.	Type	Duration/scope	if applicable Link to course no.	
1	Report on the Theoretical Chemistry Practical	5–10 pages	2	—
2	Report on the Machine Learning in Chemistry Practical	5–10 pages	4	

5	Allocation of workload	
Attendance (contact hours)	Course No. 1	1 credit
	Course No. 2	2 credits
	Course No. 3	1.5 credits
	Course No. 4	1.5 credits
Coursework (and self-study)	No. 1	1.5 credits
	No. 2	1.5 credits
Examination performance (and self-study)	No. 1	3 credits
Total credits		12

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the module.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examinations and coursework that the learning outcomes assigned to the module

  have been acquired.

6	Prerequisites
Module-specific entry requirements	A prerequisite for sitting the final module examination is the successful completion of the coursework.
Attendance regulations	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Every winter semester	
Person responsible for module/department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 12 Chemistry and Pharmacy

8	Mobility/Recognition
Applicability in other degree programmes	
Module language(s)	English
Module title in English	Data Science in Chemistry
English translation of the module components from field 3	Course No. 1: Lecture Series "Data Science in Chemistry"
	Course No. 2: Computer Lab: Theoretical Chemistry
	Course No. 3: Lecture: Machine Learning in Chemistry
	Course No. 4: Computer Lab: Machine Learning in Chemistry

9	Other
	–

degree programme	Data Science (M.Sc.)
Modules	Spectroscopic methods
Module number	DSM-CH-401

1	**Basic information**
Students' subject related semester	2 (starting in the winter semester) or 1 (starting in the summer semester)
Credit points (CP)	8
Total workload (hours)	240
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

Spectroscopic methods enable the investigation of a wide range of chemistry-related questions through the targeted examination of the structure and dynamics of matter across a broad range of length and time scales. Students are taught the theoretical and experimental fundamentals required for the independent, targeted application of modern spectroscopy.

content of teaching

The two lectures cover both fundamental and advanced theoretical and experimental concepts of magnetic resonance spectroscopy (spin relaxation, diffusion, imaging/MRI, EPR, as well as high-resolution and solid-state NMR), dielectric spectroscopy and linear optical spectroscopic methods (UV/Vis, fluorescence, IR and Raman spectroscopy) as well as non-linear optical laser spectroscopy. The course also covers aspects of the technical design of spectrometers and the targeted use of spectroscopic methods to elucidate the structure and dynamics of molecules and materials. In the practical tutorials, students work on characteristic application examples, thereby gaining insights into addressing typical scientific questions in molecular and materials characterisation using spectroscopic methods.

Learning outcomes

Students have gained a comprehensive insight into various spectroscopic methods and have learnt to assess their respective advantages and limitations. Upon completion of the module, participants will be able to apply the optimal method for characterising molecules and materials to a high standard in practice, as well as to interpret and evaluate the results obtained with confidence, taking relevant literature into account. Through their understanding of existing methods, students have acquired the ability to independently plan and carry out spectroscopic experiments carry out.

3	Structure

Components of the module

No.	LV-Category	Course format	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Methods of magnetic resonance spectroscopy	P	45 hours / 3 contact hours	90 hours
2	Lecture	Lecture	Modern methods of optical spectroscopy	P	15 hours / 1 contact hour	30 hours
3	Practical	Laboratory practical	Simulation practical on NMR spectroscopy methods	P	15 hours / 1 contact hour	45 hours

Options within the modules	None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	if applicable Link to course no.	Weighting Module mark
1	MAP	Oral examination If there are a large number of participants, the examiner may set a 120-minute written examination instead of an oral examination. This change to the examination format will be announced in a suitable manner in good time at the start of the modules .	30 min		100%

Weighting of the module mark in the overall mark	6.96%

Coursework

No.	Type	Duration/scope	if applicable Link to course no.	
1	Minutes	5–10 pages per report	3	

5	Allocation of workload

Attendance (= time spent in class)	Course No. 1	1.5 credits
	Course No. 2	0.5 credits
	Course No. 3	0.5 credits
Coursework (and self-study)	No. 1	2.0 credits
Examination performance (and self-study)	No. 1	3.5 credits
Total credits		8 credits

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination performance.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	**Prerequisites**
Module-specific entry requirements	A prerequisite for sitting the final module examination is the successful completion of the coursework.
Attendance regulations	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Always in the second half of the summer semester	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 12 Chemistry and Pharmacy

8	**Mobility/Recognition**
Applicability in other degree programmes	
Module language(s)	English
Module title in English	Spectroscopic methods
English translation of the module components from field 3	Course No. 1: Lecture: Magnetic resonance spectroscopy methods
	Course No. 2: Lecture: Modern methods of optical spectroscopy
	Course No. 3: Simulation exercises in NMR spectroscopy

9	**Other**

Specialisation: Pharmaceutical data science

degree programme	data science
Modules	Modern Aspects of Data-Driven Pharmaceutical Research
Module number	DSM-P-600

1	**Entry requirements**
Students' subject related semester	3rd semester
Credit points (CP)	6
Total workload (hours)	180
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module teaches the practical application of modern data science methods in the context of pharmaceutical issues and serves to deepen interdisciplinary skills at the interface between data science and the pharmaceutical sciences or
drug discovery. In set tutorials, students address current issues and modern concepts using data-driven methods. The aim is to develop the ability to perform data-based analysis, modelling and evaluation of pharmaceutically relevant systems. Through practical application, students learn to link pharmaceutical expertise

with data science methods and to implement them in standardised workflows.

content of teaching

The content is taught using practical exercise scenarios and datasets and depends on the teaching department and the respective lecturers. Various modules with different thematic focuses are offered. The spectrum ranges from the analysis of given datasets to the independent collection of such data, including subsequent evaluation.
In any case, the following thematic focus is offered:

- Application of data science Application within the context of computer-aided drug discovery as molecular machine learning

Further thematic focuses include, for example:

- Structure- and sequence-based protein analyses and fundamentals of protein design
- Analysis and visualisation of clinical and pharmaceutical data, such as treatment courses
- Evaluation of cell-based phenomena within the context of pharmacological research
- Modelling of galenic properties and pharmaceutical-technological parameters (e.g. solubility, release profiles)
- Data analysis in pharmaceutical biology (e.g. gene expression data, metabolite networks,

image classification)

Learning outcomes
Upon successful completion of the module, students will be able to apply typical data science methods in a pharmaceutical context. They will be able to analyse pharmaceutically relevant data sources, evaluate processed datasets and select suitable tools for visualisation, modelling and interpretation. In doing so, they will learn to link data meaningfully within specified analysis pathways. Students are familiar with the methodological foundations of modern data science tools, understand their potential applications and limitations, and are able to document and communicate their results in a comprehensible manner.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Ü		Practical tutorials in data-driven pharmaceutical research	P	75 hours / 5 contact hours	105 hours

Options within the modules:

none

4	**Examination format**

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Lecture	20 min	1	25%
2	MTP	Oral final module examination	20 – 30 mins	1	75%
Weighting of the module mark in the overall mark			5.22%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Oral presentation and discussion or report on tasks distributed and completed in advance. The nature of the coursework will be announced in an appropriate manner at the start of the course.	Presentation and discussion 5–10 minutes or 2–3 pages of notes per task.	1

5	**Allocation of workload**	
Participation (attendance or contact time)	Course No. 1	2.5 ECTS
Coursework (and self-study)	Coursework No. 1	1.5 credits

Examination performance (and self-study)	Exam No. 1	0.5 ECTS
	PL No. 2	1.5 credits
Total credits		6 credits

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the modules are only **awarded** once the modules have been successfully completed in their entirety, i.e. once it has been demonstrated through the successful completion of all examination and coursework requirements
  it has been demonstrated that the learning outcomes assigned to the modules have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance regulations	None

7	**Modules schedule**	
Frequency	Every semester	
Person responsible for module/Department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 12 Chemistry and Pharmacy

8	**Mobility/Recognition**
Applicability to other degree programmes	None
Module language(s)	German or English
Module title in English	Modern aspects of data-driven pharmaceutical research
English translation of the module components from field 3	Course No. 1: Practical exercises in data-driven pharmaceutical research

9	**Other**
	–

degree programme	data science
Modules	Fundamentals of Pharmaceutical Sciences
Module number	DSM-P-601

1	**Entry requirements**
Subject related semester	1st and 2nd semesters
Credit points (CP)	6
Total workload (hours)	180
Duration of the module	2 semesters
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

Students acquire an interdisciplinary understanding of the central fundamentals of pharmaceutical sciences through an integrated approach to biochemistry, pharmacology and clinical pharmacy. They will understand biochemical processes at the molecular level as the basis for drug action and metabolism, and grasp pharmacodynamic and pharmacokinetic principles as well as their influence on the therapeutic efficacy and safety of medicines. Furthermore, they develop a fundamental understanding of clinical-pharmaceutical issues such as drug interactions, therapeutic rationality and patient-centred drug use. The modules provide the technical foundation for understanding complex relationships between mechanism of action, biological target structure, patient variability and clinical relevance

to analyse and thus prepares students for data-driven applications in research and development.

content of teaching

The modules provide fundamental knowledge in the core areas of pharmaceutical sciences: biochemistry, pharmacology and clinical pharmacy. In the field of biochemistry, students learn about the structure and function of biological macromolecules such as proteins, enzymes and nucleic acids. Key metabolic pathways, enzyme kinetics, mechanisms of signal transduction and the biochemical basis of disease processes are covered. Particular emphasis is placed on the molecular basis of drug action and drug metabolism.
In pharmacology, the principles of pharmacodynamics and pharmacokinetics are taught, including mechanisms of action, dose-response relationships, absorption, distribution, metabolism and excretion of drugs. Important classes of drugs and their mechanisms of action, side effects and therapeutic applications are presented.
Clinical Pharmacy complements the module with patient-centred perspectives. Topics covered include medication safety, drug interactions, patient-specific factors such as age, renal function or genetics, and the rational selection of medicines for common conditions. Further content includes evidence-based treatment decisions, medication management and the fundamentals of pharmacovigilance.
This enables students to bridge the gap between biological effect, chemical structure and clinical relevance – an important prerequisite for data-driven

applications in modern drug discovery and drug development.

Learning outcomes
Upon completion of the modules, students will have a sound understanding of the biochemical, pharmacological and clinical-pharmaceutical fundamentals of drug action. They will be able to describe the structure and function of biological macromolecules as well as key metabolic and signal transduction pathways, and explain their significance for the action and metabolism of drugs. Students can apply pharmacodynamic and pharmacokinetic concepts – such as receptor binding, dose-response relationships, and absorption, distribution, metabolism and elimination – to specific drugs and assess their therapeutic relevance. Furthermore, they are able to incorporate patient-specific factors such as age, organ function or comorbidities into the assessment of pharmacotherapy. They recognise potential risks such as drug interactions or adverse effects and are familiar with the basic principles of evidence-based therapeutic decision-making and medication management. Overall, the modules enable students to link pharmaceutical-biochemical and pharmacological knowledge with clinical issues and to use this knowledge as a basis for data-driven analyses and modelling in modern drug development and personalised pharmacotherapy.

3	**Structure**

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	V		Biochemistry	P	30 hours / 2 contact hours	60 hours
2	S		Pharmacology and Clinical Pharmacy	P	30 hours / 2 contact hours	60 hours

Options within the modules:
none

4	**Examination format**

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Final oral examination in biochemistry	20–30 min	1	40%
2	MTP	Final oral examination in pharmacology	20–30 min	2	30%
3	MTP	Final oral examination in clinical pharmacy	20–30 min	2	30%
Weighting of the module mark in the overall mark			5.22%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
	None		

5	**Allocation of workload**	
	Course No. 1	1 credit

Attendance (contact hours)	Course No. 2	1 credit
Coursework (and self-study)	–	–
Examination work (and self-study)	PL No. 1 PL No. 2 PL No. 3	2 credits 1 credit 1 LP
Total LP		6 credits

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the modules are only **awarded** once the modules have been successfully completed in their entirety, i.e. once it has been demonstrated through the successful completion of all examination and coursework requirements
  it has been demonstrated that the learning outcomes assigned to the modules have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance regulations	Attendance is compulsory for Course 2, as the sessions include practical exercises and the skills taught cannot be acquired through self-study (maximum absence rate of 15% for the respective course). Failure to comply with the compulsory attendance regulations will result in the loss of the right to sit the examination.

7	**Modules schedule**	
Schedule	Biochemistry in the winter semester and Pharmacology and Clinical Pharmacy in the summer semester	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience- .	Department 12 Chemistry and Pharmacy

8	**Mobility/Recognition**
Applicability to other degree programmes	None
Module language(s)	German or English
Module title in English	Basics of Pharmaceutical Sciences
English translation of the module components from field 3	Course No. 1: Biochemistry Course No. 2: Pharmacology and Clinical Pharmacy

9	**Miscellaneous**

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degree programme	data science
Modules	Pharmaceutical and Medical Chemistry
Module number	DSM-P-602

1	**Basic information**
Subject related semester	1st to 3rd semester
Credit points (CP)	12
Total workload (hours)	360
Duration of the module	3 semesters
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

This module provides fundamental knowledge of the chemical structure of the most important classes of active substances, their interaction with the target, and the mode of action of the proteins involved. It forms the medicinal chemistry foundation that enables students to apply molecular structures, synthetic pathways and drug properties to new molecules as potential active substances within the context of drug discovery. It lays the groundwork for further modules within the context of data-driven pharmaceutical research.

content of teaching

The module covers the fundamentals of pharmaceutical and medicinal Chemistry. Key topics include: drug-target interactions (receptors, enzymes, ion channels), structure-activity relationships (SAR/QSAR), physicochemical parameters (e.g. pKa, LogP), mechanisms of action of therapeutic classes, biotransformation and ADME processes, as well as synthetic and analytical aspects of drug development. In addition, toxicophore structures, lead structure optimisation and the relationship between molecular structure and

pharmacological activity

Learning outcomes

Students acquire a sound knowledge of pharmaceutical and medicinal Chemistry as a foundation for data-driven applications in drug discovery. They understand the molecular principles of protein-ligand interactions, ADME properties, structure-activity relationships (SAR/QSAR), as well as the main therapeutic classes, their chemical characteristics and the key features of protein targets. This enables them to interpret chemical and pharmacological data professionally, derive relevant parameters for data science analyses, and apply their chemical knowledge of active substances to data-driven pharmaceutical

research.

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	V		Lecture: Pharmaceutical and Medical Chemistry III	WP	45 hours / 3 contact hours per week	75 hours
2	V		Lecture: Pharmaceutical and Medical Chemistry IV	WP	45 hours / 3 contact hours per week	75 hours
3	V		Lecture in Pharmaceutical and Medical Chemistry V	WP	45 hours / 3 contact hours per week	75 h
4	V		Lecture: Pharmaceutical and Medical Chemistry VI	WP	45 hours / 3 contact hours per week	75 h

Options within the modules:

One of the four lectures is offered each semester. Students must choose three out of four lectures.

Options within the modules:

None

4	Examination format

Examination(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MTP	Final oral examination for the first chosen lecture	10–15 min		34%
2	MTP	Final oral examination on the other two chosen lectures	20–30 min		66%
Weighting of the module mark in the overall mark			10.44%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
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5	Allocation of workload	
Attendance (contact hours)	Course No. 1	1.5 credits
	Course No. 2	1.5 credits
	Course No. 3	1.5 credits
Coursework (and self-study)		
Examination performance (and self-study)	Course No. 1	2.5 credits
	PL No. 2	5 ECTS
Total credits		12 ECTS

The modules' workload is expressed in credit points. Please note:

– The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.

- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the module.
- Credit points for the modules are only **awarded** once the modules have been successfully completed in their entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements
  it has been demonstrated that the learning outcomes assigned to the modules have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance regulations	None

7	**Modules schedule**	
Frequency	Every semester	
Person responsible for module/department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 12: Chemistry and Pharmacy

8	**Mobility/Recognition**
Applicability to other degree programmes	---
Module language(s)	German
Module title in English	Pharmaceutical and Medicinal Chemistry
English translation of the module components from field 3	Course No. 1: Lecture Pharmaceutical and Medicinal Chemistry
	Course No. 2: Lecture Pharmaceutical and Medicinal Chemistry

9	**Miscellaneous**
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degree programme	data science
Modules	Rational Drug Design
Module number	DSM-P-603

1	**Entry requirements**
Subject related semester	1st and 2nd semesters
Credit points (CP)	6
Total workload (hours)	180
Duration of the module	2 semesters
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

The module provides advanced knowledge of modern drug development and methodological approaches, with particular emphasis on current concepts from (industrial) research. This also includes modern methods of computer-aided drug discovery, without which no drug is developed today. The aim is to equip students with the ability to integrate chemical, structural and biological data in a targeted manner in order to rationally design, evaluate and further develop drug candidates. Students should thus be enabled to combine data-driven strategies with an understanding of experimental chemistry and apply them in both academic and industrial research contexts.

content of teaching

As part of the lecture on rational drug discovery, students gain insights into modern aspects of industrial drug discovery, from target identification to lead structure optimisation. This includes, for example, current methods for hit identification such as fragment-based screening or *DNA-encoded* libraries (DEL), as well as concepts such as the Lipinski Rule of Five or *the drugability* of protein binding pockets.
In addition, the lecture on computer-aided drug discovery, with an integrated tutorial (in connection with lecture/seminar), introduces students to modern computer-based methods, including the fundamentals of computational chemistry, pharmacophore- or docking-based virtual screening, and quantitative structure-activity relationships (QSAR).

Learning outcomes

Upon completion of the module, students will be able to describe and analyse the entire process of rational drug discovery, from target identification to lead structure optimisation, in a well-founded manner. They will be familiar with modern experimental strategies for hit identification, such as fragment-based screening and DNA-encoded libraries, and will be able to evaluate their use in various phases of drug discovery. Students understand concepts such as Lipinski's Rule of Five and criteria for the drugability of protein binding pockets, and can apply these critically to assess the suitability of molecular target structures or drug candidates.
Furthermore, they are proficient in fundamental methods of computer-aided drug discovery, including pharmacophore- and docking-based virtual screening, QSAR modelling and chemoinformatic analysis. They are able to integrate chemical, structural and biological data in a targeted manner within rational design processes and derive data-driven decisions
for the further development of drug candidates. Overall, students are able to

combine modern data- and model-based approaches with an understanding of experimental chemistry and apply them in current research contexts in both academic and industrial settings.

3	**Structure**					
Components of the module						
No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	V		Drug design and development	P	30 hours / 2 contact hours	60 hours
2	V		Computer-aided drug discovery	P	15 hours / 1 contact hour	30 hours
3	Pr		Tutorials on computer-aided drug discovery	P	15 hours / 1 contact hour	30 hours
Options within the modules:						
none						

4	**Examination format**				
Examination component(s)					
No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course no. (if applicable)	Weighting Module mark
1	MTP	Final oral examination	20–30 min		50%
2	MTP	Final oral examination	20–30 min		50%
Weighting of the module mark in the overall mark			5.22%		
Coursework					
No.	Type			Duration/scope	Where applicable, linked to course No.
	Successful completion of weekly assignment sheets, including submission within a specified timeframe			1–2 pages	2

5	**Allocation of workload**	
Attendance (contact hours)	Course No. 1	1 credit
	Course No. 2	0.5 credits
	Course No. 3	0.5 credits
Coursework (and self-study)	SL No. 1	1 credit
Examination performance (and self-study)	PL No. 1	1.5 credits
	PL No. 2	1.5 credits
Total credits		6 ECTS
The modules' workload is expressed in credit points. Please note: – The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.		

- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the module.
- Credit points for the modules are only **awarded** once the modules have been successfully completed in their entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements
  it has been demonstrated that the learning outcomes assigned to the modules have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance regulations	None

7	**Modules schedule**	
Schedule	Course 1 in the winter semester, Courses 2 and 3 in the summer semester	
Person responsible for module	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 12 Chemistry and Pharmacy

8	**Mobility/Recognition**
Applicability to other degree programmes	None
Module language(s)	German or English
Module title in English	Rational Drug Research
English translation of the module components from field 3	Course No. 1: Lecture Rational Drug Research
	Course No. 2 and 3: Lecture and Exercises Rational Drug Research

9	**Miscellaneous**
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Specialisation: Data Science in Physics

degree programme	Data science (M.Sc.)
Modules	Scientific Computing for Physics Problems
Module number	DSM-PH-502

1	**Basic information**
Subject related semester	1st+2nd or 2nd+3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	2 semesters
Modules status (P/WP)	WP

2	**Profile**
Aims of the module/integration into the curriculum	
In the first year of the M.Sc. data science degree programme, students deepen their knowledge in the field of scientific computing within the data science in physics specialisation, using examples from the fields of modern physics and geophysics. Students must complete courses totalling 10 credit points in this area.	
content of teaching	
The modules cover the fundamentals and applications of selected topics in physics and geophysics with regard to the field of scientific computing	
Learning outcomes	
Students have acquired in-depth knowledge in the subject area of their chosen specialisation and can explain the associated physical relationships. They can apply the knowledge they have acquired to current issues in the field.	

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	A lecture at a basic or advanced level in the field of scientific computing in the Department of Physics	P	30 (2 contact hours per week)	30
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorial (in connection with lecture/seminar) accompanying a lecture from No. 1 or No. 3	P	30 (2 contact hours)	60
3	Lecture	Lecture	A lecture at a basic or advanced level in the field of scientific computing Department of Physics	P	30 (2 contact hours)	30
4	Practical	Practical	Carrying out a project as part of an internship in the field of scientific computing in the Department of Physics	P	30 (2 contact hours per week)	60

Options within the modules:

Subject to the subject area and the structural requirements mentioned above, the modules allow students to choose freely from the range of courses offered by the Department of Physics in the fields of scientific computing and data science. The individual structure of the modules must be agreed with the module coordinators before registering for courses.

4	Examination structure

Examination(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
	MAP	Oral final module examination covering the module content	30–45 min.		100%
Weighting of the module mark in the overall mark			8.70%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving practice problems, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion: 5–10 minutes per candidate	2

5	Allocation of workload	
Attendance (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1 LP
	Course No. 4	1 credit
Coursework (and self-study)	SL No. 1	1 credit
	SL No. 2	1 credit
Examination requirements (and self-study)	PL No. 1	4 credits
Total credits		10 ECTS

The modules' workload is expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	Prerequisites
Module-specific entry requirements	No formal prerequisites; however, a basic knowledge of calculus and linear algebra is strongly .
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency	Every semester	
Person responsible for module/department	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 11 – Physics

8	Mobility/Recognition
Applicability to other degree programmes	Physics (M.Sc.) Geophysics (M.Sc.)
Module language(s)	English
Module title in English	Scientific Computing for Physical Problems
English translation of the module components from field 3	Course No. 1: Basic and advanced lectures in the field of Scientific Computing
	Course No. 2: Exercises to accompany the lectures from No. 1 or No. 3
	Course No. 3: Basic and advanced lectures in the field of Scientific Computing
	Course No. 4: Implementation of a project within the framework of the practical course in the field of Scientific Computing

9	**Miscellaneous**
	Admission to the examination is conditional upon the completion of coursework. If courses from other degree programmes are offered as part of this module, the relevant examination regulations in their current version shall apply to registration and withdrawal procedures, compulsory attendance, and participation in and passing of coursework and examinations.

degree programme	Data science (M.Sc.)
Modules	Data-based modelling of physical systems
Module number	DSM-PH-503

1	**Prerequisites**
Subject related semester	1st+2nd or 2nd+3rd
Credit points (CP)	10
Total workload (hours)	300
Duration of the module	2 semesters
Modules status (P/WP)	WP

2	**Profile**
Aims of the module/integration into the curriculum	
In the first year of the M.Sc. data science degree programme, students deepen their knowledge of scientific computing in the elective subject of Physics, using examples from the fields of modern physics and geophysics. Students must complete courses in this area totalling 10 credit points.	
content of teaching	
The modules cover the fundamentals and applications of selected topics in physics and geophysics with regard to the field of scientific computing.	
Learning outcomes	
Students have acquired in-depth knowledge in the subject area of their chosen elective and can explain the associated physical relationships. They can apply the knowledge they have acquired to current issues in the field.	

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	A lecture at either an introductory or advanced level in the field of data-driven modelling within the Department of Physics	P	30 (2 contact hours per week)	30
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorial (in connection with lecture/seminar) accompanying a lecture from No. 1 or No. 3	P	30 (2 contact hours)	60
3	Lecture	Lecture	A lecture at a basic or advanced level in the field of Data-Based Modelling FB Physics	P	30 (2 contact hours per week)	30
4	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorial (in connection with lecture/seminar) accompanying a lecture from No. 1 or No. 3	P	30 (2 contact hours)	60

Options within the modules:

Taking into account the subject area and the structural requirements mentioned above, the modules allow students to choose freely from the courses offered by the Department of Physics in the field of data-based modelling. The individual structure of the modules must be discussed with the module coordinators before registering for courses.

4	Examination structure

Examination(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
	MAP	Oral final module examination covering the module content	30–45 min.		100%
Weighting of the module mark in the overall mark			8.70%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving practice problems, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	Allocation of workload	
Participation (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
	Course No. 3	1 LP
	Course No. 4	1 credit
Coursework (and self-study)	SL No. 1	1 credit
	SL No. 2	1 credit
Examination performance (and self-study)	PL No. 1	2 credits
Examination requirements (and self-study)	PL No. 2	2 credits
Total credits		10 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been acquired.

6	Prerequisites
Module-specific entry requirements	No formal prerequisites; however, a basic knowledge of calculus and linear algebra is strongly .
Attendance policy	Attendance at courses is strongly recommended.

7	Modules schedule	
Frequency/Schedule	Every semester	
Person responsible for module/Faculty	The current module coordinators can be viewed at https://uni.ms/datascience-mv.	Department 11 – Physics

8	Mobility/Recognition
Applicability to other degree programmes	Physics (M.Sc.) Geophysics (M.Sc.)
Module language(s)	English
Module title in English	Data-Based Modelling of Physical Systems
English translation of the module components from Field 3	Course No. 1: Basic and advanced lectures in the field of Data-Based Modelling
	Course No. 2: Exercises relating to the lectures from No. 1 or No. 3
	Course No. 3: Basic and advanced lectures in the field of Data-Based Modelling
	Course No. 4: Exercises for the lecture from No. 1 or No. 3

9	**Miscellaneous**
	Admission to the examination is conditional upon the completion of coursework. If courses from other degree programmes are offered as part of this module, the relevant examination regulations in their current version shall apply to registration and withdrawal procedures, compulsory attendance, and participation in and passing of coursework and examinations.

degree programme	Data Science (M.Sc.)
Modules	Physics-Informed Machine Learning
Module number	DSM-PH-501

1	**Prerequisites**
Subject related semester	1st or 2nd
Credit points (CP)	5
Total workload (hours)	150
Duration of the module	1 semester
Modules status (P/WP)	WP

2	**Profile**

Aims of the module/integration into the curriculum

This course for the data science in Physics specialisation covers concepts, methods and application strategies in the research field of Physics-Informed Machine Learning (PyIML).
The focus is on hybrid approaches that combine prior knowledge of physics – for example in the form of symmetries, conservation laws or differential equations – with data-driven models. The aim is to utilise and further develop machine learning as a physically grounded tool. The course thus bridges the gap between data-driven methods and classical

modelling approaches in theoretical and computational physics.

content of teaching

The course builds on an introduction to machine learning and focuses on the modelling of physical systems using physics-informed learning methods. Topics covered include
, among other things:

- Fundamentals and variants of Physics-Informed Neural Networks (PINNs)
- Integration of physical structures into ML models: symmetries, boundary conditions, conservation laws, differential equations
- Data-driven modelling with incomplete physical knowledge
- Inference of physical parameters and data assimilation
- Applications in various subfields of physics and other natural sciences
- Overview of current research and outstanding challenges in the field of PyIML

In accompanying tutorials, numerical implementations are carried out using Python.

students will train their own PyIML models and evaluate their performance using realistic problems.

Learning outcomes

Students
… understand the basic idea and objectives of physics-informed learning methods,
… are familiar with key architectural principles and regularisation strategies of PINNs and related models,
… are able to integrate prior physical knowledge into machine learning methods in a targeted manner,

… acquire practical skills for the numerical implementation of PIML approaches,

... can critically evaluate physics-informed learning models and select and further develop them for specific application problems.

3	Structure

Components of the module

No.	Course Category	LV Course	Course	Status (P/WP)	Workload (h)	
					Contact hours (h)/SWS	Self-study (h)
1	Lecture	Lecture	Physics-Informed Machine Learning	P	30 (2 contact hours)	60
2	tutorial (in connection with lecture/seminar)	tutorial (in connection with lecture/seminar)	Tutorials on "Physics-Informed Machine Learning"	P	30 (2 contact hours)	30

Options within the modules:

None

4	Examination format

Examination component(s)

No.	MAP/ MTP	Type	Duration/Scope	Organisational link to course No. (if applicable)	Weighting Module mark
1	MAP	Oral examination on (1) and (2). If there are a large number of participants, the examiner may set a 90–120-minute written examination instead of an oral examination; this change to the examination format will be announced in the first module appropriate form.	20–30 min.	1	100%
Weighting of the module mark in the overall mark			4.35%		

Coursework

No.	Type	Duration/scope	Organisational link to course No. (if applicable)
1	Solving practice problems, presentation and discussion of results	Weekly assignment sheets (1–2 pages in length), presentation and discussion 5–10 minutes per candidate	2

5	Allocation of workload	
Participation (contact hours)	Course No. 1	1 credit
	Course No. 2	1 credit
Coursework (and self-study)	SL No. 1	1 credit

Examination performance (and self-study)	Exam No. 1	2 credits
Total credits		5 ECTS

The modules' workloads are expressed in credit points. Please note:

- The timing of credit allocation in a campus management system is linked to contact and attendance times, as well as to the assessment of coursework and examination results.
- If workload for self-study has been scheduled (e.g. preparation and follow-up work for courses, etc.) that is not directly related to examination or coursework, this is nevertheless allocated to the course.
- Credit points for the module are only **awarded** once the module has been successfully completed in its entirety, i.e. once it has been demonstrated through the passing of all examination and coursework requirements that the

  learning outcomes have been achieved.

6	**Prerequisites**
Module-specific entry requirements	None
Attendance policy	Attendance at courses is strongly recommended.

7	**Modules schedule**	
Frequency	Every summer semester	
Person responsible for module	The current module coordinators can be found at https://uni.ms/datascience-mv.	Department 11 – Physics

8	**Mobility/Recognition**
Applicability to other degree programmes	None
Module language(s)	English
Module title in English	Physics-Informed Machine Learning
English translation of the module components from field 3	Course No. 1: Physics Informed Machine Learning
	Course No. 2: Recitation Sessions on "Physics Informed Machine Learning"

9	**Miscellaneous**
	Admission to the examination is conditional upon the completion of coursework.