

NOTE: This document is a translation of the original document “Mitteilungsblatt – Sondernummer der Paris Lodron Universität Salzburg. 109. Curriculum für den Universitätslehrgang ‘Geographical Information Science & Systems – UNIGIS MSc (CE)’ an der Universität Salzburg (Version 2023W)” from May 30, 2023. **The original document is the legally binding document!** The English version only serves the purpose of translation.

Translation: Team UNIGIS Salzburg, September 2023

Bulletin – Special Issue of the Paris Lodron University of Salzburg

109. Curriculum for the University Programme for Further Education “Geographic Information Science & Systems – UNIGIS MSc” at the University of Salzburg (Version 2023W)

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Study Year 2022/2023

May 30, 2023

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In the meeting on May 23, 2023, the Senate of the Paris Lodron University of Salzburg enacted the curriculum for the University Programme for Further Education "Geographic Information Science & Systems – UNIGIS MSc (CE)" in the following version, which was proposed by the Curricular Commission Geoinformatics, at the University of Salzburg, in the form of a circular resolution, on May 17, 2023.

The University Programme for Further Education is a lifelong learning program and is regulated in the Austrian University Law §56(2) UG.

The legal basis is the Federal Law on the Organisation of Universities and their Studies (Universities Act 2002 - UG), Federal Law Gazette I No. 120/2002, as well as the study law section of the Statutes of the University of Salzburg, as amended.

Preliminary Remarks

Distance learning programs in the field of Geoinformatics have been offered at the University of Salzburg since 1994. This curriculum serves as a further development, based on the professional and technical progress, didactic experience, current legal framework conditions as well as the requirements of the European Higher Education Area.

The University Programme for Further Education follows a 'blended learning' approach, i.e., a flexible format for variable, in particular, open study forms and can, therefore, be offered in different organisational variants. A key element is the need for location-independent education while working. Therefore, the University Programme for Further Education in form of distance learning is supported by corresponding materials, respective forms of supervision, media, and organisational structures.

The UNIGIS University Programmes for Further Education are continuously developed within the framework of an international cooperation with partner universities and the 'UNIGIS International Association', subjected to quality assurance and positioned as a brand, worldwide.

§ 1 General Information

- (1) The total scope for the University Programme for Further Education "Geographic Information Science & Systems – UNIGIS MSc (CE)" amounts to 120 ECTS credits. It is a University Program for Further Education and comprises four semesters.
- (2) Graduates receive the academic title "Master of Science (Continuing Education)", abbreviated "MSc (CE)".
- (3) ECTS credits are assigned to all performances that are to be delivered by the students. One ECTS credit point corresponds to 25 hours of work and describes the average workload required to achieve the expected learning outcomes. The workload of one academic year corresponds to 1500 real-time hours and, thus, to an allocation of 60 ECTS credits.

- (4) According to the demand and the organisational possibilities, the University Programme for Further Education is offered to cohorts of students. The beginning and interval of which are to be determined by the program director, taking into account the demand, sufficient supervision possibilities as well as didactic requirements. Due to the special character of in-service distance learning, semester-oriented regulations for the division of the study year do not apply; a flexible schedule to be fulfilled for each student cohort is determined by the program director.
- (5) The University Programme for Further Education can be conducted in German and English as well as in mixed forms. Professional requirements and prior knowledge of students are to be taken into consideration. In addition, the University Programme for Further Education can be offered in other languages regarding instruction and support, depending on the need and available competence. This can be done in cooperation with suitable partner institutions.
- (6) Students with disabilities and/or chronic illnesses must not experience any disadvantages in the University Programme for Further Education. The principles of the UN Convention on the Rights of Persons with Disabilities, the Equality Act, and the principle of compensation for disadvantages apply.

§ 2 Admission Requirements

- (1) The prerequisite for the admission to the University Program for Further Education "Geographic Information Science & Systems – UNIGIS MSc (CE)" is a relevant Bachelor's degree or another equivalent course recognised by a domestic or foreign post-secondary educational institution, or another Bachelor's degree with research in a spatially-relevant field and working experience in this field. Supplementary examinations may be prescribed to compensate for significant domain-specific differences.
- (2) The program director has the right to request a proof of sufficient language skills.
- (3) The program director has the right to invite each applicant to a personal admission interview.

The program director decides on the admission to the University Programme for Further Education.

§ 3 Qualification Profile, Professional Fields, and Target Groups

(1) Subject of the University Programme for Further Education

Geoinformatics is a method-oriented cross-disciplinary subject based on spatial concepts and methods, which is used in the context of and in cooperation with numerous fields of application (e.g. planning, resource management, logistics, mobility, nature and environmental protection, geosciences, archaeology, marketing, or security).

The competencies taught in the university course "Geographical Information Science & Systems - UNIGIS MSc (CE)" build on basic technical and methodological knowledge of spatial sciences such as Geography and presuppose basic knowledge and skills in the practice of

Applied Geoinformatics. While the compulsory modules cover essential core areas of Geoinformatics, the elective modules allow for the individual design of specific professional qualification profiles and skills.

(2) Qualification Profile and Competencies (Learning Outcomes)

The close-knit interweaving of conceptual-methodical content with application scenarios using contemporary GI software not only leads to a critical understanding of theory, but also provides specialised skills for solving complex real-world problems. Geographical information science and its application in the form of geographic information systems thus provide the basis for the methodical-technical implementation of domain-specific knowledge. The common denominator of spatial reference is an interface competence. This allows the integration of different fields and disciplines in order to gain new insights and to develop innovative solutions.

Graduates of the University Programme for Further Education "Geographic Information Science & Systems – UNIGIS MSc (CE)" are carriers of central competences of explicit spatial information processing. In particular, they are:

- familiar with the acquisition, reference, and documentation of appropriate geodata,
- able to identify context-relevant spatial objects and attributes, model heterogeneous data sets with them in a formalised way, and build up corresponding geodatabases,
- particularly skilled to think spatially and are able to select appropriate analysis methods for solving complex problems and to use them for the extraction of information and the interpretation of spatial data,
- able to publish existing data as standards-compliant geographic web services with corresponding metadata and to design architectures of distributed geoinformation systems in order to build spatial data infrastructures, and
- trained in the use of cartographic principles to visualise and communicate spatial contents.

The program is scientifically sound and teaches a competent approach to the methods and techniques of scientific work. Graduates are able to grasp complex problems, to work independently on research questions, including hypothesis formation, goal formulation, method selection, design of a work program, collection, evaluation, and analysis of the survey data as well as a clear, coherent, and accurate presentation and interpretation of the results in speech and writing.

Student-centred learning and communication methods are used to establish a solid foundation of independent "lifelong learning" for the students. Graduates of the program are especially capable of designing and managing complex projects and applications in Geoinformatics independently, as well as cooperating within the framework of spatial data infrastructures. The goal is to provide a well-founded decision support in all application areas of Geoinformatics.

The University Programme for Further Education corresponds to level 7 (Master) of the European Qualifications Framework and qualifies the graduate for a relevant doctoral degree study.

(3) Relevance of the University Programme for Further Education for Society and the Job Market

The University Programme for Further Education "Geographic Information Science & Systems – UNIGIS MSc (CE)" meets the increasing demand for qualified specialists in numerous sectors of the economy and administration, both by its content-wise qualification profile and by its distance learning format.

Graduates of the university program "Geographical Information Science & Systems - UNIGIS MSc (CE)" are equipped with competences in methodological-technical fields and are equally active in public administration (e.g. spatial data infrastructures and Geoinformatics services and development, but also applied areas e.g. spatial planning, regional management, mobility, environmental and nature conservation) as well as in economic actors in a wide range of business forms. All sectors from data acquisition and organisation, analytical evaluation and decision support, to communication of spatial information as well as general management are covered. Having a well-founded Geoinformatics competence is often a career-defining additional qualification in all professional fields in which spatial data are relevant; for example, in planning, energy and resource management, nature conservation and environmental management, geosciences, logistics, security management, software development, marketing, surveying or archaeology.

Graduates of the University Programme for Further Education UNIGIS Master of Science are eligible for the following occupational fields, which can be connected to their professional domain of origin as an additional qualification:

- Geoinformatician (or related designations)
- Spatial data scientist
- Data analyst and GIS-cartographer
- Manager of Geoinformation and GI-infrastructure
- Geo-application developer

(4) Target Groups

The University Programme for Further Education UNIGIS MSc (CE) is aimed at:

- persons from different application disciplines who want to collect, manage, analyse, and visualise spatial data within the scope of their professional activities,
- users of Geoinformatics who want to give their sectoral and/or self-taught knowledge a sound, up-to-date basis to be able to develop independent solutions for complex problems, as well as
- self-employed persons (e.g. heads of technical offices) and employees from all sectors, including services, public administration, industry, non-profit companies, NGOs as well

as universities and research institutions, who are entrusted with the coordination or management of GI working groups, or who aspire such a position.

§ 4 Organisation and Structure of the University Programme for Further Education

The University Programme for Further Education UNIGIS “Geographical Information Science & Systems – UNIGIS MSc (CE)” consists of 11 modules, adding up to 87 ECTS credit points. Further, the Master Thesis accounts for 30 ECTS and the final Master Exam accounts for 3 ECTS.

Module	ECTS
M 01 Introduction to Geoinformatics	6
M 02 Data Modelling and Data Structures	6
M 03 Data Acquisition and Data Sources	6
M 04 Geodatabase Management (Geo-DBMS)	6
M 05 Application Development	6
M 06 Spatial Analysis	6
M 07 Visualisation and Cartography	6
M 08 Spatial Statistics	6
M 09 Open GIS and Distributed GI Infrastructures	6
M 10 Academic Guidance and Support	9
WM 01 Electives	24
Master Thesis	30
Master Exam	3
Total	120

§ 5 Types of Courses

The following types of courses are offered in the University Programme for Further Education “Geographic Information Science & Systems – UNIGIS MSc (CE):

Lecture with lab (VU) combines the theoretical introduction to a subfield and the teaching of practical skills. A lecture with lab is not subject to examinations and attendance is not compulsory. This type of course can be taken as supervised self-study distance learning unit.

Lab with lecture (UV) combines the theoretical introduction to a subfield with the teaching of practical skills, whereby the exercise character dominates. The lab with lecture is an examination-immanent course with compulsory attendance, whereby attendance in the distance learning mode can be established by temporal co-presence in online meetings.

Seminar (SE) is a scientifically advanced course. It serves the acquisition of in-depth specialised knowledge as well as the discussion and reflection of scientific topics through

active participation on the part of the students. A seminar is an examination-immanent course with compulsory attendance, whereby attendance in the distance learning mode can be established by temporal co-presence in online meetings. Different emphases of seminars are indicated in the course description, e.g. supervision seminar or project seminar.

§ 6 Study Content and Schedule

In the following, the modules and courses of the University Programme for Further Education "Geographic Information Science & Systems – UNIGIS MSc (CE)" are listed. The assignment to the semester sequence is a recommendation, and it ensures the optimal educational trail, building on prior knowledge.

The detailed descriptions of the modules, incl. the knowledge, methods, and learning outcomes, can be found in Appendix I: Module Descriptions.

University Programme for Further Education "Geographic Information Science & Systems – UNIGIS MSc (CE)"								
Module	Course	h/week	Type	ECTS	Semester with ECTS			
					I	II	III	IV

(1) Compulsory Modules

Module M 01: Introduction to Geoinformatics								
M 01.1	Introduction to Geoinformatics	3	VU	6	6			
Subtotal Module M 01		3		6	6			

Module M 02: Data Modelling and Data Structures								
M 02.1	Data Modelling and Data Structures	3	VU	6	6			
Subtotal Module M 02		3		6	6			

Module M 03: Data Acquisition and Data Sources								
M 03.1	Data Acquisition and Data Structures	3	VU	6	6			
Subtotal Module M 03		3		6	6			

Module M 04: Geodatabase Management								
M 04.1	Geo-DBMS	3	VU	6	6			
Subtotal Module M 04		3		6	6			

Module M 05: Application Development							
A total of 6 ECTS must be completed from the following courses (or equivalent courses).							
M 05.1 Basics of Application Development	3	VU	6		6		
M 05.2 Geoprocessing with Python	3	VU	6		6		
M 05.3 Developing Web-Applications with JS and Mapping Libraries	1,5	VU	3		3		
M 05.4 Automated Data Analysis with R	1,5	VU	3		3		
Subtotal Module M 05	3		6		6		

Module M 06: Spatial Analysis							
M 06.1 Spatial Analysis	3	VU	6		6		
Subtotal Module M 06	3		6		6		

Module M 07: Visualisation and Cartography							
M 07.1 Visualisation and Cartography	3	VU	6		6		
Subtotal Module M 07	3		6		6		

Module M 08: Spatial Statistics							
M 08.1 Spatial Statistics	3	VU	6			6	
Subtotal Module M 08	3		6			6	

Module M 09: Open GIS and Distributed GI Infrastructures)							
M 09.1 Open GIS and Distributed GI Infrastructures	3	VU	6			6	
Subtotal Module M 09	3		6			6	

Module M 10: Academic Guidance and Support							
M 10.1 Introduction and Orientation	1	UV	2	2			
M 10.2 Academic Work	1	UV	2		2		
M 10.3 Practice of Scientific Work	2	VU	3			3	
M 10.4 Presentation of the Master Thesis Proposal	1	UV	2			2	
Subtotal Module M 10	5		9	2	2	5	

(2) Electives according to §7

Module WM 01							
From the following courses, 24 ECTS must be completed. The range of courses is based on current, subject-specific qualification requirements, is subject to ongoing adaptation, and is determined by the responsible curriculum commission. In accordance with the provisions of §7(1), further study achievements can be credited for this module.							
*If not already selected as part of Module 5 "Application Development".							
WM 01.1 Developing Web-Applications with JS and Mapping Libraries*	1,5	VU	3				
WM 01.2 Automated Data Analysis with R*	1,5	VU	3				
WM 01.3 Basics of Application Development*	3	VU	6				
WM 01.4 Geoprocessing with Python*	3	VU	6				
WM 01.5 Enterprise GIS	3	VU	6				
WM 01.6 Environmental Monitoring	3	VU	6				
WM 01.7 EuroGIS – the European Dimension of GIS	3	VU	6				
WM 01.8 Geomarketing und Business-GIS in der Praxis (in German)	3	VU	6				
WM 01.9 Landschaftsanalyse mit GIS (in German)	3	VU	6				
WM 01.10 LiDAR in Theory and Application	3	VU	6				
WM 01.11 Project Management	3	VU	6				
WM 01.12 Automated GIS Workflows with QGIS and Python	3	VU	6				
WM 01.13 Remote Sensing	3	VU	6				
WM 01.14 Spatial Simulation	3	VU	6				
WM 01.15 Scientific Project	1,5	SE	3				
Total Module WM 01	12		24	10	10	4	
(3) Master Thesis							
			30			3	27
(4) Master Exam							
			3				3
Total	44		120	30	30	30	30

§ 7 Electives

- (1) Within the framework of the Electives (Module WM 01), credits can also be covered by external courses (e.g. courses on special and in-depth topics, or summer schools). Credits can be given for practice-oriented and professionally relevant training and educational courses, provided that they were completed successfully (required certificate should include individual performance assessment, i.e. grading) at other accredited post-secondary educational institutions and that they advance and/or complement skills and knowledge acquired in UNIGIS compulsory modules. Equivalent scientific achievements (e.g. publications) can also be recognised.
- (2) All courses can be offered as distance learning units.

§ 8 Master Thesis

- (1) The master thesis serves as proof of the ability to work independently on scientific topics in the field of "Geographical Information Science & Systems", following scientific standards, its contents, and methodologies. The master thesis is worth 30 ECTS credits.
- (2) The master thesis must contain theoretical and application-oriented parts. It must comply with the principles of scientific work in terms of form, method, and content. Special attention must be paid to the criteria of theoretical foundation, classification of the work in the topic-specific research field, topicality and practical relevance of the topic and results, methodological conception, accuracy and replicability, as well as comprehensibility and formal presentation. Specialised knowledge and competences are to be applied to concrete (practical) research questions and problems.
- (3) The topic of the Master Thesis must be taken from one of the Modules 1 to 9, or a topic from the Electives. The student is entitled to propose the topic or to choose the topic from an available pool of thesis topics from the available supervisors.
- (3) The provisions of the Statute of the Paris Lodron University of Salzburg apply for the supervision and assessment of the Master Thesis (cf. statutes §23(4)-(5)).
- (4) The topic of the Master Thesis is to be defined in a way so that it is possible and reasonable for a student to finish the thesis within six months (cf. UG2002 § 81(2)).
- (5) The Copyright Act, BGBl. No. 111/1936, must be followed while working on the master thesis and while supervising the students (cf. UG 2002 §80(2)).
- (6) The assessment of the Master Thesis is conducted by the study director, or another qualified person appointed by the study director.

§ 9 Assessment and Exams

The provisions of §§72-79 UG and the section on study affairs of the Statutes of the Paris Lodron University Salzburg apply. Examinations by means of electronic communication according to §19a of the Statutes of the Paris Lodron University Salzburg are permitted.

§ 10 Master Thesis

- (1) The university course "Geographical Information Science & Systems - UNIGIS MSc (CE)" is completed with a Master Exam, worth 3 ECTS credits.
- (2) All the required courses and the Master Thesis must be finished positively as a prerequisite to take the Master Exam.
- (3) The Master Exam consists of one examination subject. The examination subject must correspond to the module to which the topic of the Master Thesis is assigned to. One part of the examination is a presentation of the master thesis and questions about it ('defense').
- (4) The examiner is appointed by the director of studies.

§ 11 Tuition Fees

- (1) Students of the University Programme for Further Education have to pay a tuition fee.
- (2) The course fee can vary depending on the study type, the study organisation, or in case of cooperation with other universities. It is set by the vice-rector for academic affairs.

§ 12 Evaluation

The University Programme for Further Education is subject to continuous evaluations involving students, faculty members, and the program director.

§ 13 Date of Commencement

The curriculum and any amendments to the curriculum shall enter into force on the first day of the month following the announcement.

§ 14 Transitional Regulations

- (1) Students who are enrolled in the University Programme for Further Education "Geographic Information Science & Systems (UNIGIS MSc)" at the Paris Lodron University of Salzburg, (Version 2016, Bulletin - Special Issue 201, June 27, 2016) at the time when this curriculum comes into effect are entitled to complete their studies until October 31, 2026, at the latest.
- (2) Students are entitled to voluntarily change to this curriculum at any time within the admission deadlines. A written irrevocable declaration to change into this curriculum must be addressed to the study admissions office.

Annex I: Module Descriptions

Module Name	Introduction to Geoinformatics
Module Code	M 01 (GISINTRO)
Total Workload	6 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - understand the added value of the spatial dimension as a reference framework for orientation. - have an overview of the basic components of typical GIS projects and can incorporate GIS functionalities in this broader context. - have an overview of the main fields of application of GIS, can broadly outline their development, and anticipate both current trends and future market potential. The latter facilitates the effective evaluation of priorities within one's own continuing education and learning path. - can answer simple, practical problems, which include a spatial component, by means of professional GIS software. - know the basic challenges of spatial referencing and are capable of integrating spatial data, which are available in different forms of geodetic data and projections, into a single spatial reference system. - have acquired the knowledge to compare and evaluate reference systems in terms of their suitability for a specific application.
Module Contents	<p>This introductory module has a special position, being the first study component of the curriculum. It provides orientation and sets the frame for working with the subsequent modules. Specifically, it supports the students in getting familiar with the distance-learning materials and environment, which are used in subsequent modules. In addition to these objectives regarding the study format, the following domain-related contents are offered:</p> <ul style="list-style-type: none"> - Terminology and functional characteristics of geographic information systems - Typical application areas of geographic information processing - Current trends in Geoinformatics - Overview of secondary information resources for GIS in terms of life-long learning - Practical training to use professional GI software - Competent use of coordinate reference systems and projections for the practical work in GIS
Courses	M 01.1 VU Introduction to Geoinformatics (6 ECTS)
Type of Assessment	Assignment

Module Name	Data Modelling and Data Structures
Module Code	M 02 (DATAMODL)
Total Workload	6 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - have a profound overview of common data structures in GIS software, - can effectively compare and evaluate geodata structures based on their requirements and characteristics; consequently, they can identify the appropriate data structures for a specific problem of a project. - are aware to the vagueness of day-to-day terminology and concepts in describing spatial relations and recognise the necessity of formal-logical data models as alternative to their description in GIS. - understand the approach, structure, and use of markup languages, can verify XML instances regarding their syntax and validate them against XML schemas. They can interpret GML schema files and create simple GML files. - are capable to contrast GML with alternative formats of web-based data exchange and to identify the most suitable technology.
Module Contents	<p>This module provides a profound overview of common data structures and data models in GIS. It explores how the real world around us can be displayed (application- and goal-oriented) in all its complexity with data models and data structures. Specific module contents include:</p> <ul style="list-style-type: none"> - Basics of a formal description of spatial phenomena and relationships - Modelling spatial information - Spatial models – data models – data structures - Vector model - Grid models (raster) - Representation of continuous space - Object-oriented data models - Multidimensional spatial data models - Data modelling with UML - Introduction to mark-up languages (XML, GML) - Standards (GML) and quasi-standards (GeoJSON) for structuring and communication of spatial data - Complementary training in another professional GI software
Courses	M 02.1 VU Data Modelling and Data Structures
Type of Assessment	Assignment

Module Name	Data Acquisition and Data Sources
Module Code	M 03 (DATSRCAQ)
Total Workload	6 ECTS

Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - know the most common methods for geodata acquisition, understand their basic functioning, can evaluate their suitability for practical application scenarios, and can plan and guide data acquisition projects. - have the skills to collect and process primary data. They can, for example, acquire and process GNSS data, can apply digital image processing methods in order to extract thematic information from multispectral image data, use services for geocoding address data, or digitise analogue data using automated processes. - can integrate heterogeneous datasets of various formats and sources into a homogenous geodatabase. - are aware of the importance of data documentation and familiar with the appropriate metadata standards. - know about the strategies for building and working with correct topology geodatabases.
Module Contents	<p>The third module applies to the practical aspects of the 'population' of spatial data structures with real-world information. It provides an overview of primary and secondary acquisition methods with the goal of gaining insight into the genesis and the suitability of spatial data for specific use cases. A substantial part is the access and the report of important digital resources as well as the valorisation of geo-information by a standard-compliant documentation. Specific module contents include:</p> <ul style="list-style-type: none"> - Identification of required data from the application and user perspective - Data quality and cost - Surveying - Global Navigation Satellite Systems (GNSS) - Photogrammetry - LiDAR - Optical sensors and radar - Remote sensing platforms (satellite, aircraft) - Data acquisition with UAV - Image analysis - Digitising, scanning, vectorising - Data with indirect location reference, geocoding of address data - Data transfer: norms and standards, format transformations - Metadata, metadata standards - National and global spatial data sources, open government data - Legal and ethical aspects, copyright, and open licenses of geodata
Courses	M 03.1 VU Data Acquisition and Data Sources
Type of Assessment	Assignment

Module Name	Geodatabase Management
Module Code	M 04 (GEODBMS)

Total Workload	6 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - can evaluate the range and performance of database systems for managing geographical data and can compare them with other forms of data storage. - know the typical phases of the data modelling process and can automatically perform this process on the basis of simple, practical application scenarios. - can check existing ER models on efficiency and correctness, and can develop ER diagrams for their own use cases. - can create simple databases, including the graphical representation of the data model and the definition of data types for attribute and geometry data. - can perform and optimise queries using SQL statements. This applies to attribute queries as well as to simple spatial queries. - understand the use of geodatabases in combination with GI systems.
Module Contents	<p>In this module, the conceptual foundations of conventional database systems are introduced by working on hands-on examples. On this basis, the knowledge is transferred to spatial data management and geodatabase systems. Specific module contents include:</p> <ul style="list-style-type: none"> - Architecture of database management systems - Database design and documentation - Relational data modelling - Normalisation - Solid basics of SQL query language as a universal language for data definition, data control, and data management - Practical work with a SQL front-end - Glossary of terms and specifications of GeoDBMS - Spatial models in DBMS - Spatial SQL operations according to OGC - Spatial indexing
Courses	M 04.1 VU Geodatabase Management
Type of Assessment	Assignment

Module Name	Application Development
Module Code	M 05 (APPLDEV)
Total Workload	6 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ol style="list-style-type: none"> (1) have a structured knowledge of software development, which allows them to work in developer-teams or to communicate with developers, as an expert in GIS. (2) understand the basic structures of procedural and object-oriented programming and can use these skills to for their own programming tasks. (3) can develop their own programs to adapt existing application and automate workflows.
Module Contents	<p>This module introduces the students to GIS-related programming. It covers an overview of different software architectures and technologies that are used in different job-related contexts. To fit the needs of this practical approach,</p>

	students can choose from a selection of courses, which do all cover the learning objectives mentioned above.
Courses	A total of 6 ECTS must be completed from the following courses (or equivalent courses): M 05.1 VU Basics of Application Development (6 ECTS) M 05.2 VU Geoprocessing with Python (6 ECTS) M 05.3 VU Developing Web-Applications with JS and Mapping Libraries (3 ECTS) M 05.4 VU Automated Data Analysis with R (3 ECTS)
Type of Assessment	Assignment

Module Name	Spatial Analysis
Module Code	M 06 (GEOGANAL)
Total Workload	6 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - can identify the potential and limitations of spatial analysis to capture relationships and trends in spatial data and to support spatial decision-making processes. - can analyse complex, real-world problems by dissecting them into methodically manageable sub-tasks and processing them with state-of-the-art GIS software and tools. - have a wide repertoire of analytical methods and techniques and can evaluate their suitability for a particular purpose. They can also conduct a sensitivity analysis for parametrisation within a method. - know the advantages of graphical modelling tools for structuring extensive analysis procedures. - can assess the role and influence of alternative data models on the result of an analysis method and can conduct analysis across data models. - know a selection of appropriate analytical methods and techniques for the generation of decision-relevant information in complex problem solving tasks.
Module Contents	<p>Spatial analysis methods are a central feature of geographic information systems. This core area within Geoinformatics aims at translating domain problems, based on conceptual problem structuring, towards analytical methods and tools. This module introduces the fundamental methods and techniques of geographical analysis. Specific module contents include:</p> <ul style="list-style-type: none"> - Graphic modelling as a practical methodology for the design and documentation of analytical processes - Map algebra as an ordering scheme, appropriate operators - Spatial selection and aggregation, regionalisation - Aggregate data, MAUP and ecological fallacy - Distance scales and distance metrics, applications of distance-based methods - Cost surfaces in surface transport and dispersion analyses - Spatial interpolation (deterministic) - Multi-thematic integration (intersection, assessment, multi-criteria method) - Route optimisation and allocation in networks - Terrain analysis (slope, exposure, radiation, visibility, hydrological run-off)

	- Description of forms and patterns
Courses	M 06.1 VU Spatial Analysis (6 ECTS)
Type of Assessment	Assignment

Module Name	Visualisation and Cartography
Module Code	M 07 (VISCARTO)
Total Workload	6 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - can apply cartographic data representation methods efficiently and profitably in various project phases: from data exploration, to data analysis, to the presentation of results. - can develop media- and purpose-oriented representations of spatial data that are appropriate for the respective target audience. The resulting maps take data inherent characteristics (data level, data distribution, standardisation), perceptual-psychological conditions (gestalt perception, colour) as well as (carto-)graphic conventions into account. - can draw on classical cartographic concepts such as generalisation or classification as well as on new visualisation techniques such as 3D visualisation and animation. - can reflect on cartographic products critically, identify areas for improvement, and contribute substantially to the discourse on cartographic work.
Module Contents	<p>Knowledge on the visual communication of spatial information is essential since nearly every GI professional actively designs maps at some point. This module aims at professionals from different domains to take advantage of cartographic data processing approaches for their respective tasks. Specific module contents related to conventional as well as digital forms of publication (web-mapping, mobile-mapping) include:</p> <ul style="list-style-type: none"> - Cartographic application fields and paradigms - Cartographic design process - Generalisation and classification - Perception of forms and visual variables - Colour models and use of colour (including consideration of colour vision deficiency) - Development of map symbols and interaction - Map annotation and text - Thematic maps, diagrams, and diagram maps - Map design and layout - Digital devices and output formats - 2.5D/3D visualisation - Web-mapping technologies and APIs - Dynamic visualisation
Courses	M 07.1 VU Visualisation and Cartography (6 ECTS)
Type of Assessment	Assignment
Module Name	Spatial Statistics

Module Code	M 08 (SPATSTAT)
Total Workload	6 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - can apply basic non-spatial statistics methods in a differentiated and meaningful way. - can develop solutions for spatial statistical problems independently. - can apply spatial statistical methods by means of common statistics and GIS software. This includes simple statistical analyses with the scripting language R.
Module Contents	<p>This module reviews and reinforces fundamental concepts and techniques of non-spatial statistics. In addition, the principle of spatial autocorrelation is introduced as a basis for understanding the specifics of spatial statistics and the main methods of spatial statistics are discussed. Specific module content includes:</p> <ul style="list-style-type: none"> - Comparison between non-spatial and spatial statistics - Introduction to statistical programming with R - Descriptive non-spatial and spatial statistics - Exploratory spatial data analysis - Basics of inferential statistics - Classical and geographically weighted regression analysis - Structure discovery methods (cluster analysis and point pattern analysis) - Analysis of spatial autocorrelation (Moran's I, variography etc.) - Probabilistic interpolation (geostatistics) - Validation of interpolation results
Courses	M 08.1 VU Spatial Statistics (6 ECTS)
Type of Assessment	Assignment

Module Name	Open GIS and Distributed GI Infrastructures
Module Code	M 09 (Open GIS and Distributed GI Infrastructures)
Total Workload	6 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - know about the "open" paradigm and its components such as open data, open source software, and interoperability supported by open standards, as well as their importance in the GI context. - know relevant OGC standards and the architecture of distributed systems. - are able to use existing services and interfaces of a geodata infrastructure for their own problems and questions. - are able to publish standard-compliant geographic web services and to integrate geodata from different sources into their own applications via standardised interfaces.
Module Contents	<p>Spatial data infrastructures encompass technology, standards, policies, and legal aspects, as well as humans. This module introduces key Open Geospatial Consortium (OGC) standards and how they can be used in the context of spatial data infrastructures to ensure data interoperability. Specific module content includes:</p> <ul style="list-style-type: none"> - Specific issues related to interoperability - Overview of standards, OpenGIS, and distributed architectures

	<ul style="list-style-type: none"> - Concepts, models, and interfaces from the OpenGIS world (e.g.: XML, GML, Web Map Service, Web Feature Service, Metadata and Catalogue Services, OGC API standards) - Conception of strategic geoinformation projects - Spatial data infrastructures and their implementation on municipal, national, and supranational level - Practical use of OpenGIS interfaces (query and integration of geodata)
Courses	M 09.1 Open GIS and Distributed GI Infrastructures
Type of Assessment	Assignment

Module Name	Academic Guidance and Support
Module Code	M 10 (ACADSUPP)
Total Workload	9 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - have an overview of the structures, process, and scope of the University Programme for Further Education including performance expectations as a basis for individual planning of the University Programme for Further Education. - have an overview of new developments and trends in Geoinformatics. - can write scientific papers independently.
Module Contents	<p>This module covers the entire course of study. As a study-accompanying module, it serves, on the one hand, as an introduction to the curriculum and for orientation with regard to individual specialisation and optional offers, as well as for setting accents in order to draw attention to new developments and trends. On the other hand, it serves as an introduction to scientific working methods. Specific module contents include:</p> <ul style="list-style-type: none"> - Content-related, organisational, and administrative framework within the University Programme for Further Education - Classical techniques of scientific work, such as literature research, citation, and writing of scientific texts - New forms of subject-specific communication and collaboration in Web 2.0 - Introduction and support in the implementation of a scientific project - Subject-specific accents and suggestions for scientific topics for the implementation in students' master's theses - Presentation and discussion of the proposed master thesis topic
Courses	<p>Depending on the study organisation, a selection is offered from the following courses, some of which are continuously assessed (dt.: prüfungsimmanent):</p> <p>M 10.1 UV Introduction and Orientation (2 ECTS)</p> <p>M 10.2 UV Academic Work (2 ECTS)</p> <p>M.10.3 VU Practice of Scientific Work (3 ECTS)</p> <p>M 10.4 UV Presentation of the Master Thesis Proposal (2 ECTS)</p>
Type of Assessment	Assignments, or independent contributions and active participation in courses of an examination-immanent (dt.: prüfungsimmanent) nature.

Module Name	Electives
Module Code	WM 01
Total Workload	24 ECTS
Learning Outcomes	<p>Graduates of the module</p> <ul style="list-style-type: none"> - Expand the core competencies and skills acquired in the core modules by selected topics to foster their individual learning objectives.
Module Contents	<p>The Electives offer the opportunity to expand and deepen the conceptual, methodological and / or technical knowledge acquired in the core modules 1 to 9. A series of courses on current, specialised topics are offered in the Electives, from which students can choose in order to set an individual focus.</p> <p>In addition to the courses offered, external training courses can also be completed (cf. §7(1)). Special attention is also given to technical skills. Up to 50% of the ECTS points can have a focus on the use of a specific software.</p> <p>The following courses (offered in German and English) can be chosen at present (the offer is subject to ongoing adaptation and is determined by the responsible curriculum commission):</p>
Courses	<p>WM 01.1 VU Developing Web-Applications with JS and Mapping Libraries (3 ECTS)*</p> <p>WM 01.2 VU Automated Data Analysis with R (3 ECTS)*</p> <p>WM 01.3 VU Basics of Application Development (6 ECTS)*</p> <p>WM 01.4 VU Geoprocessing with Python (6 ECTS)*</p> <p>WM 01.5 VU Enterprise GIS (6 ECTS)</p> <p>WM 01.6 VU Environmental Monitoring (6 ECTS)</p> <p>WM 01.7 VU EuroGIS – the European Dimension of GIS (6 ECTS)</p> <p>WM 01.8 VU Geomarketing und Business-GIS in der Praxis (in German) (6 ECTS)</p> <p>WM 01.9 VU Landscape Analysis with GIS (6 ECTS)</p> <p>WM 01.10 VU LiDAR in Theory and Application (6 ECTS)</p> <p>WM 01.11 VU Project Management (6 ECTS)</p> <p>WM 01.12 VU Automated GIS Workflows with QGIS and Python (6 ECTS)</p> <p>WM 01.13 VU Remote Sensing (6 ECTS)</p> <p>WM 01.14 VU Spatial Simulation (6 ECTS)</p> <p>WM 01.16 SE Scientific Project (3 ECTS)</p> <p>*If not already selected as part of Module 5 "Application Development".</p>
Type of Assessment	According to the selected courses.

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